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Abstract

To develop information which the Texas Education Agency could use in planning the development of electronic technology programs in Texas junior colleges, this study was designed to provide: (1) an assessment of current programs, (2) information about the employment of electronic technicians in Texas, and (3) other types of information for use in planning facilities and equipment. Questionnaires were used to survey the 78 commercial research or testing laboratories, 21 telephone companies, 59 commercial broadcasting stations, and 15 manufacturers of electronic equipment who did not maintain testing laboratories, while questionnaires and personal interviews were used to gather data from the 19 junior colleges who participated. A chi-square test of significance of independence of two variables was applied to each of the instructional units listed in the questionnaire. Conclusions were: (1) School and industrial representatives were not in total agreement as to the teaching emphasis, (2) They closely agreed on the future importance of the units and types of equipment a technician should be able to operate well, and (3) Junior colleges have not been a principal supplier of electronic technicians. Recommendations are included. (GR)

ELECTRONIC TECHNOLOGY STUDY

Texas Education Agency

1969

AN INVESTIGATION INTO PUBLIC POST-SECONDARY ELECTRONIC TECHNOLOGY PROGRAMS IN TEXAS WITH IMPLICATIONS FOR PLANNING

By

Jerauld B. Wright
Principal Investigator

Dr. James L. Boone, Jr.
Project Director

This research was conducted in cooperation with the Texas Education Agency and Texas A&M University (Industrial Education Department and Texas Engineering Experiment Station).

August, 1969

ABSTRACT

An Investigation Into Public Post-Secondary Electronic Technology Programs in Texas With Implications For Planning. (August, 1969)

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Directed by: Dr. James L. Boone, Jr.

The purpose of this study was to provide information which the Texas Education Agency could use in planning the development of electronic technology programs in junior colleges. The populations included principal employers of electronic technicians in Texas and junior colleges in Texas which offered electronic technology curriculums.

Data were collected concerning (1) relative agreement between school and industrial representatives as to the amount of teaching emphasis which should be given various instructional units, (2) differences in teaching emphasis indicated necessary by representatives from different industries, (3) employers' and school representatives' estimates of the future importance of each unit, (4) adequacy of physical facilities at the various colleges, including plans for expansion, (5) inventories of laboratory and test equipment and hand and shop tools (both available and needed) at the various schools, (6) recently completed and pending course additions or changes in

curricular emphasis at the various schools, (7) teachers' comments concerning industrial experience, (8) present numbers of technicians employed and projections of future needs, and (9) employers' assessments of certain general abilities of junior-college-trained electronic technicians. A series of 35 mm color slides representative of present school facilities was assembled.

Two techniques of collecting data were employed. Questionnaires were used to survey industries and schools concerning the curriculum. The industrial form of the questionnaire also provided information as to the employment of technicians. Each of the school representatives was also interviewed in person. Usable returns were obtained from (1) nineteen junior colleges, (2) seventy-eight commercial research and/or testing laboratories, (3) twenty-one telephone companies, (4) fifty-nine commercial broadcasting stations, and (5) fifteen manufacturers of electronic equipment who did not maintain testing laboratories.

Principal conclusions were:

1. Schools and industries disagreed on the degree of teaching emphasis which should be placed on 192 of the 421 units studied.

2. Schools and industries estimated significantly different future importance for 18 of the 421 units.

3. Raters from the different industries desired different degrees of teaching emphasis for 227 of the 421 instructional units.

4. Present school facilities were adequate.

5. A considerable need for newer types of laboratory and/or test equipment was found at certain schools.

6. There was no serious lack of hand and shop tools at any of the schools.

7. Teachers' opinions varied widely concerning the necessity for and optimum amount of industrial experience.

8. Texas junior colleges have not been a principal training source for electronic technicians currently employed in Texas.

9. There is presently a shortage of well-trained electronic technicians in Texas.

10. The demand for electronic technicians will probably continue at the present level for at least five years.

11. Employers ranked general abilities of junior-college trained electronic technicians in order as follows (from most satisfactory to least satisfactory):
(1) speaking, (2) reading, (3) writing, (4) math related to electronics, (5) electronic theory, and (6) ability to perform hand skills and/or use test equipment in practical situations.

12. Employers and teachers were agreed that the oscilloscope was the most important item of equipment for a technician to be able to operate well, followed by VTVM's, multimeters, signal generators, and other common test equipment.

Recommendations based on analysis of the data included:

1. Research of this type should be repeated periodically, with special consideration to proposals whereby data would be gathered through photographs and personal interviews.

2. Consideration should be given to establishing a policy whereby teachers could be reimbursed for expenses directly related to summer industrial employment, such as moving costs and housing.

3. Provisions should be made for more direct involvement of teachers in planning program development.

4. An attempt should be made to attract more students into current training programs.

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CHAPTER I

INTRODUCTION

One of the most profound changes in our society during recent years has been the rapid increase in the number of technical workers employed in industry. This change has occurred so quickly that accurate figures describing its magnitude are not readily available.

> The Census Bureau does not indicate what portion of the professional and technical job family is composed of technicians. This will vary somewhat from one community to another, but it is known that the technician is the most rapidly expanding phase of this job family . . . .[1]

The Engineering Manpower Commission reports that the electronics and electrical industry showed the greatest increase in technician employment in 1965 and 1966, with strong growth indicated for the decade ahead.[2] "Technician employment grew even faster than that of engineers between 1964 and 1966. The chemical and electronic

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NOTE: The citations in this dissertation follow the style suggested in Turabian's Manual for Writers of Term Papers, Theses, and Dissertations (3rd ed., revised), U. of Chicago Press, 1967.

[1]Richard L. Burns, "Guidelines for Establishing Area Vocational-Technical Schools and Programs," School Shop, XXV:9 (May, 1966), p. 24.

[2]"EMC Report Surveys Demand for Engineers in 1966," Technical Education News, XXVI:4 (May, 1967), p. 7.

industries were the greatest gainers, with increase each year between 22 and 25 per cent."[3]

This large increase in the demand for technicians has brought about an educational phenomenon--the critical need to provide training for adequate numbers of technicians. Rapid technological advancements, especially in electronics, have added to the difficulty of providing adequately trained technicians. Each new development has represented an increase in the curriculum content. In addition, it has been difficult to communicate training needs to schools as rapidly as technology has advanced. This research was undertaken to provide the Texas Education Agency with information concerning current needs of public, post-secondary electronic technology programs.

Background

The background of this project can be partially described by stating that little research concerning the training needs of electronic technicians had been done in Texas. Several factors probably contributed to this situation.

1. Electronic technology programs were offered by twenty-five colleges throughout Texas, but large physical distances between them probably discouraged the exchange

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[3]Ibid.

of research information and ideas concerning development of these programs. Distance probably also contributed in some degree toward hampering efforts of the Texas Education Agency to coordinate activities of the various programs.

2. The needs of local, large companies which employ many technicians influenced the curriculum at some colleges more than others. The colleges' efforts to meet local needs may also have been a factor which discouraged interest in investigating the situation over the whole state.

3. Graduate educational research in Texas colleges and universities has not been oriented toward electronics education on the technical-vocational level.

4. Information about the number of electronic technicians employed in Texas and the companies which employ them was not readily available. For this study, it was necessary to do a preliminary survey to gather this information. The necessity of doing such a preliminary survey may have discouraged previous research efforts.

5. The Texas Advisory Committee on Vocational Education found that "insufficient emphasis has been placed on the program evaluation function at the State

agency level."[4] This suggests that activities of the various offices, committees, and personnel of the Texas Education Agency were not strongly oriented toward evaluation of existing programs.

The employment situation concerning electronic technicians at the time the study was initiated should also be considered in describing the background. The preliminary survey revealed that (1) a large number of technicians were employed in the industries concerned, and (2) there was a general shortage of qualified electronic technicians. "Good technicians . . . are in extremely short supply today. There will be a continuing need for electronic and mechanical technicians in the foreseeable future."[5] "We have a chronic and continuing shortage of manpower."[6]

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[4]<u>Guidelines for the Development of Vocational Education in Texas Through 1975-76: A Report of the Texas Advisory Committee on Vocational Education</u>, Ben R. Howell, chairman (Austin, Texas: Texas Education Agency, 1968), p. 41.

[5]Letter from R. C. Mays, Director of Personnel, Southwest Research Institute, San Antonio, Texas, May 28, 1968.

[6]Letter from Bonner McLane, Executive Secretary, Texas Association of Broadcasters, May ?3, 1968.

Statement of the Problem

The central problem from which this investigation originated was that the Texas Education Agency needed current information concerning public post-secondary electronic technology programs. Obviously, a great many kinds of information would have been useful in assessing the effectiveness of current training and in planning the development of these programs. It would have been impossible to gather all useful information without a large staff and considerable financial resources. Therefore, the study was confined to an effort suitable for a single researcher and the limited financial resources which were available.

Objectives.--Part of the limiting process mentioned above was done by establishing specific objectives for this research. These objectives were:

1. Survey employers of electronic technicians within certain industries to determine what teaching emphasis should be placed on various units in the electronic technology curriculum.

2. Compare the responses from the different industries.

3. Compare the responses from industry with similar information obtained from representatives of school programs.

4. Gather information which would be helpful in planning the development of electronic technology curriculums and training facilities.

5. Assemble a file of 35mm color slides of present training facilities.

6. Assemble a file of floor plans representative of present training facilities.

7. Determine the amount of tools and equipment available at present training locations, as well as tools and equipment which may be needed at each location.

Significance of the Problem

The rapid advancement of technical knowledge in electronics requires frequent evaluation of the training required to enter electronics-related occupations. Industrial needs must be communicated to schools where such training is offered, so that appropriate curriculum changes may be made. Unless this is done, the training will not meet employers' requirements and the value of the technicians' education will be reduced.

This research was significant because it contributed information helpful in assessing the effectiveness of electronic technology programs in Texas. It was also a source of data on which to base plans for the development of these programs.

Hypotheses

Three hypotheses were formulated to guide this research. These hypotheses were:

1. There will be no significant difference in the degree of teaching emphasis indicated necessary for each instructional unit by school and industrial raters.

2. There will be no significant difference in the degree of teaching emphasis indicated necessary for each instructional unit by raters from among the different industries.

3. There will be no significant difference in school and industrial raters' estimates of the future importance of each unit.

Assumptions

Certain assumptions were made concerning the procedure which was followed in conducting this investigation. These assumptions were:

1. Schools and industries in Texas would cooperate.

2. A written instrument could be developed to gather the necessary information from all the schools and industries concerned.

3. The training requirements for electronic technicians employed within the various industries were based on a body of knowledge in which similarities and/or differences could be identified and compared.

4. School and industrial personnel would be able to estimate the future importance of each unit, basing their estimates on the present importance.

Limitations

To further delimit this study, it was decided to gather information only from Texas-based companies likely to employ electronic technicians. The investigation was confined to:

1. Member companies of the Texas Association of Broadcasters.

2. Member companies of the Texas Telephone Association.

3. Companies in Texas which are included in Major Group 36 of the Standard Industrial Classification system (manufacturers of electrical and electronic equipment, components, and supplies).

4. Research laboratories and/or facilities identified in the Catalogue of Research Facilities in Texas.[7]

An additional limitation was that data were gathered only from electronic technology programs in public, post-secondary schools in Texas. These were identified in the publication, 1968-69 Directory--Technical and Vocational Programs in Post Secondary Institutions.[8]

Definitions

The following definitions are presented for a clearer understanding of the terms used in the study.

Electronic technician.--One who "applies electronic theory, principles of electrical circuits, electrical testing procedures, physics, and related subjects, to layout, build, test, troubleshoot, repair, and modify developmental and production electronic equipment . . . ."[9]

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[7]Industrial Economics Research Division, Texas Engineering Experiment Station, Catalogue of Research Facilities in Texas (College Station, Texas: Texas A&M University, 1967), p. 1-230.

[8]Texas Education Agency, 1968-69 Directory--Technical and Vocational Programs in Post Secondary Institutions (Austin, Texas: Texas Education Agency, 1968), p. 16-44.

[9]Dictionary of Occupational Titles. Volume I: Definitions of Titles. 3rd ed., 1965, p. 246.

The term "technician" as used in this study also refers to an electronic technician.[10]

Electronic technology program.--A technical course of study offered by junior colleges for the purpose of training electronic technicians. This term is used synonymously with "training program" and "public, post-secondary electronic technology program."

Laboratory and test equipment.--Electronic meters and test instruments, and/or other special apparatus associated with and necessary for advanced instruction in electronics.

Hand tools and shop equipment.--Items such as pliers, hammers, screwdrivers and other common hand tools necessary for working with electronic components; also, machinery such as vises, drill presses, soldering guns and

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[10] For this study, this term was used to refer to a person with the training necessary to perform the work described above. It is important to make this distinction because data were collected from industries on the basis of the number of workers currently employed as electronic technicians, regardless of the sources from which they may have received this training. In soliciting cooperation of industrial firms, "non-degree electronic technician" was also used in an attempt to communicate the idea that the study was concerned with workers who had specialized training in electronics. For this data, inferences were made for electronic technology programs being conducted in junior colleges.

other shop equipment useful in doing electronics-related shopwork.

Instructional unit.--A concept or group of concepts, concerned with or related to the same topic in the study of electronics, which can be (but does not necessarily have to be) taught in one class session. This term is used synonymously with "unit" and "teaching unit."

Procedure

The procedure followed in conducting this research was as follows:

I. Prepare for the research.
   A. Review literature.
      1. Literature describing previous research.
      2. Literature concerning the situation in Texas.
   B. Prepare proposal to be submitted to the Texas Education Agency.
   C. Prepare materials.
      1. Develop survey instruments.
      2. Submit instruments to a jury for evaluation.
      3. Make revisions suggested by the jury.
   D. Identify school and industrial populations.

E. Enlist cooperation of schools and industries.

II. Gather the data.

A. Mail questionnaires to industries.

B. Mail follow-up letters as necessary.

C. Arrange interview with spokesmen for each school.

D. Mail questionnaire to school spokesmen prior to interview.

E. Visit each school at appointed time.

III. Analyze the data.

A. Test hypotheses.

B. Tabulate information concerning tools and equipment available and needed at each school.

C. Tabulate data concerning training and employment of electronic technicians.

IV. Prepare summary, conclusions, and recommendations.

V. Report the results.

CHAPTER II

REVIEW OF LITERATURE

This research was planned and conducted to gather information which would contribute to several different educational and industrial situations. Before conducting the investigation, it was necessary to determine the characteristics of each situation. To provide this information, many types of periodical literature and publications of professional and trade associations were reviewed. Many of these references related to only one aspect of the study. References to these sources have been made at various points throughout this dissertation, particularly where information from one of these writings was related to a specific situation encountered during the investigation.

Related Research

A review of literature revealed only one recent study conducted in Texas which pertained to post-secondary electronics education. This was a nation-wide study to identify the mathematical concepts needed by entry level electronic technicians and to determine the relative understanding of these concepts by students graduating from public post-secondary electronic technology programs.[1] Twenty-one public post-secondary schools in Texas which offered electronic technology programs participated in Simons' project.

This research was closely related to a study performed by Vasek in 1966. The purpose of Vasek's study was to identify the units which should be included in the electronic technology curriculum in the Southeastern United States, and to determine what teaching emphasis was thought necessary for each unit by electronic-related industries and by teachers in electronic technology programs.[2]

<u>Research into terminal education in Texas</u>.--Several studies pertaining to terminal education in Texas were identified. Inasmuch as electronic technology training is to some extent terminal education, literature describing these projects was included.

The importance of junior college terminal education in Texas was established by Horton. After analyzing data

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[1]Jerold Jean Simons, "Relative Understanding of Mathematical Concepts by Students Majoring in Electronics Technology" (unpublished D.Ed. dissertation, Texas A&M University, 1967), p. 1-2.

[2]Richard Jim Vasek, "A Comparative Analysis of Electronic Content in Post-High School Technical Institutes and Electronic Technology Requirements of Industry" (unpublished D.Ed. dissertation, Texas A&M University, 1967), p. 2-3.

gathered from graduates of terminal programs offered by four junior colleges in Texas, he wrote:

> Endorsement of the high value of junior college terminal curricula appears to have been secured by the impressive ratings, in all criteria employed in the study, reflected by junior college terminal employees when compared with contemporary high school graduates without college training. The study appears to have established a great value for vocational-technical training beyond high school level through junior college terminal curricula.[3]

Coordination between terminal programs at different junior colleges in Texas was found in need of improvement by Bass. Among the recommendations he made after completing his research was: "A more efficient coordination of the programs between schools is desirable. This is especially true in programs which require expensive equipment . . . ."[4]

A status study of terminal education practices and programs in Texas was conducted by Garland. On completion of the study, he recommended that " . . . further research and study should be given to the terminal program of the

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[3]Henry Allen Horton, Jr., "An Evaluation of the Effectiveness of Junior College Terminal Curricula" (unpublished Ph.D. dissertation, University of Texas, 1962).
Abstract: Dissertation Abstracts XXIII, p. 3723.

[4]Wilbur Anthony Bass, "A Study of the Impact of the Vocational Act of 1963 on Selected Texas Public Junior Colleges" (unpublished Ph.D. dissertation, University of Texas, 1967).
Abstract: Dissertation Abstracts XXVIII, p. 1641-A.

Texas Public Junior Colleges, particularly in the areas of curriculum development . . . ."[5]

Brenholz studied certain vocational occupations in Texas, and analyzed changes in Texas in-school and out-of-school vocational education as these changes related to occupational changes. He concluded that " . . . industrial education deals with a large segment of the occupational population; it should be augmented in both program areas."[6] Brenholz recommended " . . . that additional study be made in three areas: (1) expansion of existing vocational programs, (2) expansion of vocational guidance services, and (3) the relationship of higher education and vocational education."[7]

Research concerning electronics education.--Studies related to electronics education at the post-high school level have been performed in other states. Several of

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[5]James J. Garland, "The Current Status of Terminal Education Programs of the Public Junior Colleges of Texas" (unpublished Ph.D. dissertation, Baylor University, 1958), p. 227.

[6]Gerald Severn Benholz, "A Study to Determine Relationships Between Vocational Education Curricular Evolution and Some Aspects of Occupational Evolution" (unpublished Ph.D. dissertation, University of Texas, 1967).
Abstract: Dissertation Abstracts XXVII, p. 4161-A.

[7]Ibid.

these investigations pertained to curriculum or program evaluation, and were related to this study because it was concerned with similar activities.

Trego studied " . . . the extent to which the electronics technology curriculum as interpreted by the faculty of the Technical Institute of Temple University was meeting the job requirements of technicians as rated by employers in the electronics industry."[8] Among the recommendations Trego made at the conclusion of the project was:

> Consideration should be given to a periodic evaluation of the extent to which the electronics technology curriculum . . . is meeting the needs of industry, and to take those steps necessary to ensure continued flexibility and adaptability of the offerings.[9]

The knowledge necessary to perform the major tasks involved in electronic technicians' work were identified by Mills. He found that electronic technicians' work was divided into eight major tasks: (1) diagnosing trouble in systems, (2) adjusting and/or operating, (3) servicing,

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[8]John W. Trego, "A Study of the Job Requirements of Electronic Industries and the Electronic Technology Curriculum of Temple University Technical Institute" (unpublished D.Ed. dissertation, Temple University, 1958), p. 1.

[9]*Ibid.*, p. 94.

(4) assembling, (5) installing, (6) designing and computing, (7) application, distribution, and sales in electronics, and (8) quality control and testing.[10]

Brown compared the manipulative operations which an industrial worker should be able to perform and the sizes and types of electronic equipment needed to perform these operations with equipment used and operations taught in industrial teacher education. He found " . . . a rather close agreement between the extent to which various operations occurred in work performed by electronic production workers . . . and the extent to which the same operations are found in courses taught by college respondents."[11]

Jelden equated the informational content of textbooks and other instructional materials used in electrical courses offered to industrial arts teacher education majors with electrical knowledge needed by workers employed in electronics-related industries. He found that the industries surveyed did not unanimously agree on the

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[10] Boyd Calvin Mills, "Identification of Major Task and Knowledge Clusters Involved in Performance of Electronic Technicians' Work" (unpublished Ph.D. dissertation, Washington State University, 1967). Abstract: Dissertation Abstracts XXVIII, p. 546-A.

[11] George Jackson Brown, "Manipulative Operations and Electronic Equipment Needed in Industrial Teacher Education Based on Industrial Practices" (unpublished D.Ed. dissertation, University of Missouri, 1960). Abstract: Dissertation Abstracts XXI, p. 2607.

topics which should be studied, but " . . . substantial agreement did exist regarding about two-thirds of the topics."[12] Jelden further concluded that "although no single source analyzed includes all the units or topics of electrical knowledge contained in the analysis, there is general agreement between the different books and instructional materials as to content."[13]

Related Industrial Surveys

Because this research was partially concerned with the employment situation concerning electronic technicians in Texas, certain efforts of industry to evaluate employment potential constituted pertinent literature. Two industrial surveys were related directly to this project.

During the summer of 1968, Texas Instruments, Incorporated, sponsored a survey to evaluate the possibility of training electronic technicians through co-op programs. The survey arose from the difficulty encountered by this corporation in hiring well-trained personnel. Results of the survey showed that 541 electronic technicians could be

[12]David Lawrence Jelden, "Electrical Informational Content Included in Industrial Arts Teacher Education vs. Knowledge Required of Electronic Technicians" (unpublished D.Ed. dissertation, University of Missouri, 1960). Abstract: Dissertation Abstracts XXI, p. 1470-71.

[13]Ibid.

trained through utilization of present facilities, " . . . if Texas Instruments, Incorporated recruited the students."[14]

The Texas Association of Broadcasters conducted a survey on the educational level of all personnel employed in the broadcast industry in Texas. This survey was completed in late 1968. In the report of the results of this survey is the following:

> It is hoped that the junior college system that is growing in the state will produce a combination vocational and academic curriculum for the first two years of college that will make first phone operators available directly from college to broadcasting.[15,16]

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[14] Letter from Joseph A. Patterson, Technical Staffing Representative, Texas Instruments, Incorporated, December 5, 1968.

[15] Texas Association of Broadcasters, "Report on 'Solving our Manpower Shortage,'" Austin, 1969, p. 3-4. (Reproduced by spirit duplicator process.)

[16] Such a program has been initiated at Amarillo College. See <u>1968-69 Directory--Technical and Vocational Programs in Post Secondary Institutions</u> published by the Texas Education Agency, p. 17.

CHAPTER III

PROCEDURE

This research was conducted to gather current information concerning the training of electronic technicians in Texas. Data were gathered from industrial firms in Texas which employed (or were potential employers of) electronic technicians, and from public, post-secondary schools in Texas where electronic technology programs were offered. The data were concerned with training needs of technicians, suitability of available training facilities, and certain types of information to aid in planning the overall development of electronics training on the post-secondary level.

It was desirable to conduct the research in distinct phases because of the orderliness thereby lent to the procedure of contacting and keeping account of replies from the large number of industrial firms involved. The following description of procedures is given under subtitles corresponding to the phases in which the research was conducted.

Identification of Population

The population from which data were gathered during this project consisted of two broad categories:

(1) public, post-secondary schools in Texas which offered electronic technology training and (2) industrial firms in Texas which employed (or were potential employers of) electronic technicians. Identification of member institutions in the two categories was considerably different.

Identification of schools.--To identify the schools in this study, it was necessary only to consult the Texas Education Agency. A directory containing this information was furnished.[1]

Identification of industrial firms.--Considerable difficulty was encountered in attempting to identify companies which employed (or were likely to employ) electronic technicians. The first attempt to identify these companies was to request the Texas Employment Commission to furnish a list of companies which employed electronic technicians. It was determined that the Commission was unable to do this because employment information was not available by occupational groups.[2] Further investigation revealed that employment information in Texas was available only by industry according to the Standard Industrial

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[1]Texas Education Agency, 1968-69 Directory--Technical and Vocational Programs in Post Secondary Institutions (Austin, Texas: Texas Education Agency, 1969), p. 1-53.

[2]Letter from T. L. Barrow, Texas Employment Commission, May 3, 1968.

Classification System. It was therefore decided to choose industries from groups in the Standard Industrial Classification, if possible.

Examination of the Standard Industrial Classification Manual[3] revealed several groups of industries which might conceivably offer employment to electronic technicians. These were (1) Major Group 36 (manufacturers of electrical and electronic equipment, components, and supplies), (2) Major Group 48 (communications industry, including commercial broadcasters), and (3) Industry Number 7397 (commercial testing laboratories).

It was required that each group contain a sufficient number of companies located in Texas to make a suitable population. Several organizations were contacted and asked for information which might aid in determining numbers of companies in the groups which initially appeared to be usable. Among these organizations were the Texas Association of Broadcasters, the Texas Telephone Association, the Dallas office of the American Testing Association, the Texas Research League, the Bureau of Business Research on the campus of the University of

[3] Office of Statistical Standards, U. S. Bureau of the Budget, Standard Industrial Classification Manual (Washington: U. S. Government Printing Office, 1967), p. 168-179, 216-217, 285.

Texas, and the Industrial Economics Research Division of the Texas Engineering Experiment Station on the campus of Texas A&M University.

Information from these sources identified populations of adequate size in each of the groups originally considered. All companies in Texas classified under Major Group 36 were identified in the Directory of Texas Manufacturers,[4] furnished by the Bureau of Business Research. Commercial research facilities were listed in the publication, Research Facilities in Texas,[5] supplied by the Industrial Economics Research Division of the Texas Engineering Experiment Station on the campus of Texas A&M University. The Texas Association of Broadcasters and the Texas Telephone Association both furnished lists of their members. These two lists contained a large proportion of all firms in Texas which are categorized in Major Group 48.

Seven hundred and fourteen research laboratories, both private and public, were listed in the Catalogue of Research Facilities in Texas. It was suspected that

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[4]Ida M. Lambeth, ed., Directory of Texas Manufacturers (Austin, Texas: Bureau of Business Research, The University of Texas at Austin, 1967), p. 611-623.

[5]Industrial Economics Research Division, Texas Engineering Experiment Station, Catalogue of Research Facilities in Texas (College Station, Texas: Texas A&M University, 1968), p. 1-230.

not all these laboratories employed electronic technicians, but the catalogue's brief description of each laboratory's operations and staff gave no positive evidence that electronic technicians were or were not employed. This underlined the necessity to perform the preliminary survey, to identify companies in this large group which did employ technicians.

The descriptions of many of the laboratories stated that no technicians of any kind were employed. These laboratories were excluded from the population. All facilities operated by institutions of higher education were also eliminated from the list at the suggestion of various members of the professional staff at Texas A&M University. The consensus was that in a college or university, a large part of any research-related work requiring knowledge of electronics would be performed by staff members or students employed part-time. Therefore, they felt that few electronic technicians would be employed by colleges and universities.

As might be suspected, several of the research laboratories were owned by or operated as service facilities of manufacturing companies. In these cases of duplication, the unit in question was considered to be a research facility and was eliminated from the list of manufacturers in Major Group 36.

Preliminary Survey of Industrial Firms

After the initial populations were identified, it was necessary to determine which companies employed electronic technicians and then to solicit their cooperation. This was done by means of a letter to the president or general manager of the firm (Appendix A). The same form letter was used to contact companies in all four groups, with appropriate word changes to fit the situation. All letters were duplicated by means of offset printing. Inside addresses were typed in with the same typewriter used to prepare copy for the press.

The large number of letters required for the preliminary survey and throughout the study dictated that form letters be used. Each letter sent was signed by the principal investigator in an attempt to alleviate the lack of personal interest sometimes associated with form letters.

If the name of the president or general manager of a company was known, the letter was addressed to him. If not, the letter was addressed to "President, company" (or "General Manager, Station xxxx" in the case of broadcast stations).

In the initial letter, the purpose of the study was explained and the firm was asked to cooperate.

Obligations which the company would assume by agreeing to participate were outlined. The president (or general manager) was asked to appoint an individual who was cognizant of the training needs of electronic technicians employed by the firm, and who would thereafter be the company's spokesman or "contact" individual. It was explained that all subsequent correspondence in regard to this project would be addressed to this individual.

For two reasons, each company president was asked to suggest one person to serve in this capacity. First, it committed the president to a definite decision concerning whether or not to cooperate in the study. Also, the individual named would hopefully feel a personal commitment to the project, thereby increasing the percentage of returns.

A pre-addressed, stamped reply card was included in each letter (Appendix B). On the card were spaces for the president of the company to indicate (1) the number of electronic technicians employed, (2) whether the firm would or would not cooperate, and (3) the name and address of the "contact" individual. Company names and addresses were typed on the cards before the letters were sent, to simplify the companies' replies and to assure that all cards returned could be identified.

As soon as the reply card from a company was returned the company spokesman was sent a letter to verify his appointment (Appendix C). Again, a form letter was designed to allow use in each group of industries with only the change of pertinent words. These letters outlined the manner in which the remaining portion of the study would be conducted. The purpose of the research was also explained to assure that industrial spokesmen would have this information.

In each group of industries surveyed, there were replies from companies which desired to participate but which did not employ technicians. Depending on the group in which the company was included, two methods of handling these situations were employed. If the reply was from a manufacturing firm, a telephone agency, or a testing laboratory, the company president was notified by letter that only employers of technicians were included in the population. Broadcast stations, however, were included in the population even though they did not employ electronic technicians. Broadcasters who did not employ technicians were included because of the probability that this research would contribute information which would be useful in alleviating the manpower shortage in the industry.

Preliminary surveys of the three groups of industries were conducted one at a time. Research labs were contacted first, communications firms second, and manufacturers last. The surveys were done in this order primarily because considerable time was required to address all the letters and envelopes for the large number of companies in each group. Doing the surveys one group at a time offered other advantages, however. It eased the task of keeping account of responses, which also made it easier to conduct follow-up surveys.

Follow-up letters were sent to all firms not replying to the original letter. Again, form letters were developed which could be used in all three industrial situations if appropriate word changes were made (Appendix D). In all three instances, the follow-up letters were mailed as soon as replies to the original letter stopped. This time period in all three cases was about three weeks. The follow-up mailing to companies in each group was done before the original letter was mailed to companies in the next group.

Each follow-up letter contained a copy of the original letter and another reply card. Company spokesmen identified through the follow-up mailing were also sent a letter verifying their appointment.

Results of Preliminary Industrial Surveys

Following is an analysis of the results of preliminary surveys of the research labs, the communications industry, and the manufacturers, respectively. Reasons are not readily apparent for the varying levels of response among the groups of industries. It was probably due in part to different levels of interest at the managerial level.

Preliminary survey of research laboratories.--Of the 558 laboratories contacted, 376 (67.4 per cent) responded to the first letter. A follow-up mailing three weeks later to the remaining 182 firms yielded 104 additional replies (57.1 per cent). The total number of replies, 480, represented a return of 86.0 per cent. In addition, there were 14 "miscellaneous" replies. These included laboratories which had gone out of business, merged with another company, or moved and left no forwarding address.

One hundred and four (21.7 per cent) of the 480 laboratories which replied were employers of electronic technicians who desired to participate in the study. There were 21 (4.4 per cent) laboratories which did not desire to participate but which did employ technicians. Firms which did not employ technicians and did not desire to participate numbered 342 (71.2 per cent). Thirteen (2.4 per cent) laboratories did not employ technicians but would have participated.

A total of 5,154 electronic technicians were employed by cooperating firms, or an average of 49.6 technicians employed per cooperating industry. Twenty-one of the non-cooperating laboratories employed a total of 58 technicians, which represented an average of 2.8 technicians per firm.

Preliminary survey of broadcasters.--The total number of broadcasters contacted was 200. Ninety (45.0 per cent) of these companies responded to the first letter. A second mailing to the remaining 110 stations produced 61 replies (55.5 per cent). The total number of replies, 151, represented a return of 75.5 per cent from both mailings. In addition, one letter was returned because it was undeliverable.

Of the 151 stations which replied, 97 (64.2 per cent) employed technicians and indicated a willingness to cooperate. Nineteen stations (12.6 per cent) stated they employed electronic technicians but did not want to participate. Twenty-six stations (17.2 per cent) replied that they did not employ technicians and did not want to take part in the project. The remaining nine replies

(6.0 per cent) were from stations which desired to participate but did not employ electronic technicians.

A total of 515 technicians were employed by the 106 cooperating stations, or an average of 4.9. The 19 non-cooperating stations which were employers of technicians had a total of 38 technicians on their combined staffs, or an average of 2.0 technicians per station.

Preliminary survey of telephone companies.--The initial population of telephone companies surveyed included 94 members of the Texas Telephone Association. There were 44 replies to the first letter (46.8 per cent). A second mailing to the remaining 50 telephone companies resulted in 25 replies (50.0 per cent) or 69 total replies from the 94 companies which were asked to participate (73.4 per cent). A merger was reported between 2 of the 69 replying firms, leaving an actual total of 68 companies which replied to the initial contact letter. In addition, 3 of the 94 letters in the first mailing were returned as undeliverable, in cases where the addressee had gone out of business or moved and left no forwarding address.

Of the 68 companies which replied, 33 (48.5 per cent) employed electronic technicians and desired to participate in the study. Nine companies (13.2 per cent) employed technicians but did not want to participate, and 4 companies (5.9 per cent) did not employ technicians but would have participated. The remaining 22 companies (32.4 per cent) did not employ technicians and did not want to be included in the project.

The 33 cooperating companies employed a total of 155 electronic technicians, or an average of 4.7 technicians employed per cooperating company. The 9 companies which employed technicians but did not wish to participate employed a total of 36 technicians, or a mean of 4 technicians each.

Communications industry as a whole.--The total number of companies included in the initial survey of the communications industry was 294--200 broadcasters and 94 telephone companies. Replies were received from 151 broadcasters and 68 telephone companies. The total number of replies, 219, represented a response level of 74.5 per cent from this group.

From the total of 219 companies, 33 telephone companies and 97 broadcast stations employed electronic technicians and wished to participate in the study. This total, 130, was 59.4 per cent of the companies which replied. Nine telephone companies and 19 broadcasters, a total of 28 (12.8 per cent), employed technicians but did not want to cooperate. Twenty-two telephone companies and 26 commercial broadcast stations stated that they did not employ electronic technicians and that they wished to be excluded from participation in the project. These 48 companies represented 21.9 per cent of the 219 which responded to the preliminary survey.

Four telephone companies did not employ technicians but would have participated in the project. These 4 companies, 1.8 per cent of the 219 replies to the initial survey, were excused from participation. However, 9 broadcast stations which did not employ technicians but stated a willingness to furnish data were included in the list of cooperating industrial firms. The basis for this irregularity was that this study was a potential source of information which might contribute to alleviating the shortage of trained personnel in the Texas broadcast industry. These 9 stations constituted 4.1 per cent of the 219 members of the communications group.

In summary, the population of participating industrial firms within the communications industry consisted of: (1) 33 telephone companies and 97 broadcast stations which employed technicians and stated a desire to participate, and (2) 9 broadcast stations which did not employ technicians but which did state a willingness to furnish data. The total number of cooperating firms in the communications group was therefore 139.

Preliminary survey of manufacturers.--Letters were mailed to 311 manufacturers at the outset of the initial survey of this group. Replies to the first letter were received from 132 companies (42.4 per cent). Follow-up letters mailed to the remaining 158 companies produced an additional 75 replies (47.5 per cent). The total number of replies to both letters, 207, was 66.7 per cent of the 311 manufacturers contacted. In addition, 21 letters were returned because they were undeliverable.

There were 33 companies (15.9 per cent) which employed electronic technicians and desired to contribute information toward the research. Seventeen (8.1 per cent) of the manufacturing companies employed technicians but did not want to participate, and 150 (72.6 per cent) of the responding companies did not employ technicians and did not elect to participate. Companies which did not employ technicians but which would have participated numbered 6 (2.9 per cent). In addition, 21 (6.8 per cent) letters mailed to manufacturers were returned because they were undeliverable.

The 33 cooperating manufacturers employed 221 technicians, a mean of 6.7 per company. Fifty-five technicians were employed by 16 non-cooperating manufacturers, an average of 3.3 per company.

Preliminary Survey of Junior Colleges

The procedure followed in soliciting cooperation of schools was similar to that used for industrial companies. Twenty-five junior colleges which offered electronic technology training were listed in the 1968-1969 Directory of Technical and Vocational Programs which was obtained from the Texas Education Agency. A letter was sent to the president of each of these junior colleges, explaining the purpose of the study and outlining the method by which the study would be conducted (Appendix E). Each college president was asked to suggest someone who would serve as the school's spokesman during the project. A reply card was included in each letter, on which the president could indicate whether or not the school would participate (Appendix F). Space for the name and address of the school's spokesman was alsc available on the card.

All twenty five of the reply cards were returned. Six of the twenty-five schools declined to participate. One program was presently inactive, two programs were established during the current year and had not progressed sufficiently to be of value to the study, and three colleges declined to participate for unidentified reasons. The remaining nineteen took part in the project.

The nineteen school spokesmen identified during the preliminary survey were sent letters verifying their appointment (Appendix G). These letters explained the purpose of the study and the method by which it would be conducted to assure that school representatives would understand the nature of the project.

Development of Materials

Four different forms were used to gather the data. They were:

1. An "Information Form" for gathering the desired information about the curriculum and information about the training and employment of electronic technicians.

2. A form to obtain an inventory of laboratory and test equipment at each school.

3. A form to obtain an inventory of hand tools and shop equipment at each school.

4. A form to guide the progress of and record information received during the interview at each school.

Information form.--The questionnaire used to gather data about the electronic technology curriculum consisted of eight pages, including the cover sheet and instructions (Appendix H). Five pages comprised a checklist wherein responses concerning the curriculum could be made by placing check marks in the proper columns. The last page was devoted to collecting information about numbers of technicians employed, sources from which they received their training, and other pertinent facts.

The form was printed on three colors of paper. One color was assigned to each industrial group surveyed. Questionnaires sent to manufacturers were on light blue paper. Those sent to research labs were on white paper, and yellow paper was selected for the survey of the communications firms. This idea was suggested by consultants at the Data Processing Center on the campus of Texas A&M University, to aid in quickly identifying any selected questionnaire by as many characteristics as possible.

The forms were printed in two colors, red and black. This was done to emphasize that two kinds of information were being gathered about each unit. It also made the form more attractive and distinctive.

To facilitate the use of the same form by industrial and school personnel, alternate forms of the final page were required. Inasmuch as employment information did not pertain to school situations, the final page of copies sent to schools simply requested school spokesmen to retain all materials until the interview.

The checklist portion of the form (concerning the curriculum) was a modification of an instrument devised for a similar study conducted in the Southeastern United States during 1966 and 1967. Vasek conducted this study to identify what content should be included in the curriculum of electronic technology programs in the area and to determine the degree of instructional emphasis each unit should be given.[6]

The process by which Vasek identified this content consisted essentially of: (1) identification of textbooks used by three or more electronic technology programs in the area, (2) analysis of subject matter of each book to identify the units it contained, (3) grouping of the units into major divisions and subdivisions, (4) revisions, additions, and other changes suggested by a curriculum specialist, and (5) evaluation by a jury of experienced electronics teachers.[7] The resulting

[6]Richard W. Vasek, "A Comparative Analysis of Electronic Content in Post-High School Technical Institutes and Electronics Technology Requirements of Industry" (unpublished doctoral dissertation, Texas A&M University, 1967), p. 2-3.

[7]*Ibid.*, p. 23-41.

instrument consisted of 12 major divisions, 54 subdivisions, and 435 units.[8]

It was obvious that utilization of the subject matter so recently identified by Vasek would offer at least two advantages: (1) more time would be available to gather other types of valuable data, and (2) duplication of effort would be avoided. No information was found to suggest that the subject matter Vasek identified would not be representative of curriculum requirements elsewhere. Therefore, it was decided to structure a major portion of this research around the basic design of the form Vasek developed. Permission to use the form was readily granted, along with suggestions for improving it:

> The three point rating scale should be changed to a four point scale or at least a fuller explanation of the meaning of "Taught in Depth," "Discussed Briefly," "Not Taught," . . . would be in order. The only negative comments I recall pertained to this. The instructors, especially, said they had a difficult time in deciding whether to check "Taught in Depth," vs. "Discussed Briefly" or "Discussed Briefly" vs. "Not Taught."[9]

In accordance with these suggestions, and to provide a means of gathering opinions of the future importance of

[8] *Ibid.*, p. 41.

[9] Letter from Dr. R. J. Vasek, Mississippi State University, April 29, 1968.

each unit, the basic format Vasek developed was revised. A column was added to provide for four degrees of instructional emphasis instead of three. Three columns were added to gather estimates of the future importance of each unit.

The revision process depended upon (1) the selection of another term descriptive of a degree of teaching emphasis and usable with the three terms originally selected by Vasek, or (2) development of four different terms. The first alternative was pursued.

The terms "Taught in Depth" and "Discussed Briefly" appeared to be further apart in meaning than the terms "Discussed Briefly" and "Not Taught." Discussion of the meanings of the three terms with other students and faculty advisors strengthened this suspicion. Any new term selected had to be meaningful in context with the three original terms, and convey an impression of emphasis between two of them. "Emphasized" seemed to suggest less emphasis than "Taught in Depth" and more emphasis than "Discussed Briefly," and also appeared to be in proper context. Therefore, it was tentatively chosen as the fourth term.

The decision of whether the four terms were suitable rested on their meeting two requirements. First, meanings of the terms should rest at four approximately equally-spaced points in a continuum of all possible degrees of teaching emphasis. Second, the terms should be definable with reference to characteristics that would be familiar and meaningful to people in different technical fields.

To provide information on which to base this decision, fifty students pursuing graduate degrees in Industrial Education were polled. These students represented a wide range of experience in different industrial occupations, and all but two of them had teaching experience. Each person in the group was given a sheet on which he was asked to define the four tentatively selected terms in his own words and give his opinion concerning how well the four terms represented the continuum (Appendix I). Thirty-seven of these sheets were returned.

Thirty-six of the students who replied agreed that the terms "Taught in Depth", "Emphasized", "Discussed Briefly", and "Not Taught" did represent four approximately equally-spaced points in a continuum of teaching emphasis. All thirty-seven of the students supplied a definition for each term.

The definitions these students supplied were analyzed. It was noted that certain phrases were repeated in many of the definitions. These often-repeated phrases were selected as being most likely to communicate meanings effectively. The phrases were easily incorporated into a table of definitions which could be used to explain and define the terms. The four terms in question were judged suitable to use as column headings, and the table of definitions was placed in the directions for filling out the information form.

Headings were also necessary for the three columns wherein data would be collected concerning estimates of the future importance of each item. Inasmuch as no concrete assessment of the present importance of any item was available, it was necessary to select terms which would allow each respondent to base his estimates on his own assessment of this importance. "More Important," "About the Same," and "Less Important" were chosen for these headings. A brief statement was developed to describe the purpose of these three columns and explain how to provide the information requested. This statement was also placed in the directions for completing the form.

With the selection of column headings and the development of instructions completed, the revision of the original version of the questionnaire was complete. An additional page (the last page) was added to collect data on numbers of electronic technicians employed in Texas and sources from which the technicians received their training, as well as estimates of future employment needs. Space was provided for respondents to broadly assess the general effectiveness of principal subject-matter areas of junior college electronics training in Texas. This page of the form was designed to be self-explanatory, and as simple to complete as possible.

<u>Hand tool and shop equipment list</u>.--A form was developed to inventory hand tools and shop equipment available at each participating school (Appendix J). An important criteria for this form to meet was that it require a minimum of time to complete. The type of form which best met this requirement was a list of tools and equipment commonly used in electronics-related work, with a space after each listed item for the school representative to write the number of that item available in his laboratory. This list was developed through consultation

with electronics teachers and examination of pertinent literature.[10, 11]

Laboratory and test equipment list.--A form on which to inventory laboratory and test equipment available at each participating school was also necessary (Appendix K). It was developed simultaneously with the "Hand Tool and Shop Equipment List." The same general format and sources of information were utilized.

Interview guide.--To assure that the same topics would be discussed with each school representative and to provide a means of recording information gathered during interviews, a form to guide these discussions was developed (Appendix L). It was designed (1) to provide for gathering data on objectives not covered by the mailable forms previously discussed, and (2) to allow for the flexibility which distinguishes face-to-face discussion from written communication.

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[10] Prakken Publications, Incorporated, Modern School Shop Planning (4th rev. ed.; Ann Arbor, Michigan: Prakken Publications, Incorporated, 1965), p. 109-127.

[11] U.S. Department of Health, Education and Welfare, Office of Education, Electronic Technology: A Suggested 2-Year Post-High School Curriculum, Area Vocational Education Program Series No. 2, (Washington, D.C.: U. S. Government Printing Office, 1966), p. 96.

Jury evaluation.--When the materials for gathering data were developed and refined as much as possible, they were evaluated by a jury of six persons known to be experienced in electronics education (Appendix M). The jury was asked to evaluate the materials on the basis of (1) completeness and correctness of information, (2) communicability of the forms, including directions for filling them out, (3) practicality of information requested in light of the purpose of the study, and (4) general suggestions. Directions were furnished each jury member (Appendix N). All six jury members returned the materials.

Suggestions made by the jury were not extensive. No single topic on any of the forms received comments from more than five of the members. Only in the "directions" section for the Information Form did two or more jury members make the same suggestion. On the basis of information gained through the jury's criticisms, the following changes were made:

1. Wording was changed in the directions for completing the Information Form, the Laboratory and Test Equipment List, and the Hand Tool and Shop Equipment List.

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2. Items were added to provide coverage of newer types of instruments in the "Test Equipment" section of the Information Form.

3. All responses entitled "other" (requiring the listing of additional units) were eliminated from the Information Form.

4. Items were combined, added, or eliminated throughout the Information Form where such changes would eliminate duplication, provide greater clarity, or provide for responses which would otherwise have been omitted.

5. The heading of the last division of the check-list portion of the Information Form was changed from "Industrial Electronics" to "Other Applications of Electronic Devices."

The final version of the Information Form consisted of 12 major divisions, 52 subdivisions, and 421 instructional units. This compared to 12 major divisions, 54 subdivisions, and 435 instructional units in the original form developed by Vasek.[12]

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[12] Vasek dissertation, p. 41.

Collecting the Data

When materials had been developed and identification of populations was complete, collection of data was begun. The procedure followed in collecting data from industrial firms was considerably different from that of gathering data from schools.

Survey of industries.--Data were collected from participating industrial firms entirely by means of first-class mail. Each company spokesman identified during the preliminary surveys was sent a copy of the Information Form. A cover letter accompanied each form (Appendix O). A stamped, addressed envelope was also included, to provide company spokesmen with a means of returning the questionnaire.

Company spokesmen who did not return the Information Forms within three weeks were sent a follow-up letter (Appendix P). Another questionnaire and another return envelope were enclosed in the follow-up letters. Table 1 illustrates the number of letters sent and the number of replies received for each group of industries.

TABLE 1

SUMMARY OF RETURNS FROM THE INDUSTRIAL SURVEY

Industrial Groups	First Mailing	Returns From First Mailing	Follow-up Mailing	Returns From Follow-up Mailing	Total Returns
Research Laboratories	104	62 (59.6%)	44	22 (50.0%)	84 (80.8%)
Telephone Companies	33	16 (48.5%)	17	10 (58.8%)	26 (78.8%)
Commercial Broadcasters	106	66 (62.3%)	40	11 (27.5%)	77 (72.6%)
Manufacturers	33	12 (36.4%)	21	9 (42.9%)	21 (63.6%)
Totals	276	156 (56.5%)	122	52 (42.6%)	208 (75.4%)

Survey of school programs.--Gathering of data from college and junior college electronic technology programs was done partially by mail and partially through personal interviews with representatives at the various schools. Appointments were made with the "contact" individual at each school. These appointments were scheduled in a sequence so arranged that schools in the same general area of the state could be visited on one trip.

From one to two weeks prior to the interview, each school representative was sent a copy of the Information Form, a Laboratory and Test Equipment List, and a Hand Tool and Shop Equipment List. This was done in an attempt to provide spokesmen with adequate time to complete the forms prior to the interview. It also provided them with a more complete orientation to the project prior to the interview. School spokesmen were also asked to provide floor plans of their facilities. Arrangements were made to pick up these materials during the visit to each school.

A series of 35mm color slides was taken of the training facilities at each school. Classrooms and laboratories were photographed, along with outstanding or unique features of training facilities. Each school's representative was asked to point out features which he thought would contribute toward a true representation of the situation at his school.

Informing Participants of Results of the Study

After analysis of data, a factual summary of the results was prepared and sent to all industrial spokesmen who had indicated they would like to be so informed (Appendix Q). This summary consisted of twelve pages, including (1) comparisons of responses concerning training needs expressed by the three groups of industries, (2) summaries of the number of electronic technicians employed in each group of industries, (3) summaries of the number of additional electronic technicians needed within each of the industrial groups, and (4) summaries of the levels of response from the three groups of industries. Each school spokesman was sent a copy of this dissertation.

CHAPTER IV

ANALYSIS OF DATA

Two methods of collecting data were utilized during this research. Data from companies which employ electronic technicians were gathered through questionnaires sent by mail. Information from schools which train electronic technicians was collected by means of questionnaires and through personal interviews.

Data Collected During School Interviews

The purpose of this study was to assemble information which would be useful in coordinating the development of electronics training at the technical level. Therefore, information about several different aspects of maintaining such training programs was sought. Each of these aspects was discussed with every school representative interviewed, following the Interview Guide (Appendix L).

Plans for expansion of facilities.--At each school visited, the person interviewed was asked about the college's plans for development of physical facilities. The responses obtained have been summarized in Table 2. This information was obtained on an informal basis. Statements regarding future utilization of facilities were made in view of existing conditions, and would be subject to whatever influences might be encountered in the future.

TABLE 2

SUMMARY OF DATA GATHERED IN REACTION TO THE QUESTION: "ARE THERE PLANS FOR EXPANSION OF FACILITIES?"

School	Comments Concerning Plans for Expansion
A	The electronic technology program will expand to a new room in the same building. More room will be needed later as emphasis continues to shift to computers.
B	There are no plans for construction at present; another lecture room will be needed in two years.
C	Room is available in the present building for the electronics program to take over more space if needed.
D	The electronics program will take over another lab. It is available now.
E	A new vocational-technical building will be built. Local funds have been approved. The contract will be let when state and federal funds are approved, possibly during late 1969.
F	The entire campus is presently housed in temporary buildings. Long-range plans include a new campus. The first new building will be a library, on which construction may start this year. The electronics program will not move from present facilities for three or four years.
G	Lab facilities are available in the present building for the electronics program to move into if necessary.
H	Present facilities are adequate. Electronics program is in its first year of operation.

TABLE 2--Continued

School	Comments Concerning Plans for Expansion
I	There are no plans to expand facilities.
J	The district is presently building six new campuses; electronics will be offered on five of the seven. Present campus will remain.
K	There are no plans to expand facilities.
L	The electronics program is in its second year of operation. Present facilities are two years old and are adequate.
M	A new math or science building is planned for the near future. The electronic technology program may move into it.
N	The program was started in a new building last year. It is presently housed in one room. Consideration is being given to using the present room for a lab and using a room across the hall for a lecture room.
O	The present building is three years old. Facilities are adequate for two or three more sections of students.
P	There are no plans for expansion of facilities at present.
Q	Construction of a new building was recently begun. Electronics will have space in the new building.
R	The Vocational-Technical Building was new two years ago. Electronics presently has half of the third floor, which is adequate.
S	A new vocational-technical building was completed last year. Present facilities are adequate.

<u>Purchases of laboratory and/or test equipment</u>.--At each college visited, the person interviewed was asked (1) what new laboratory and/or test equipment was purchased this year, (2) what new laboratory and/or test equipment was purchased last year, and (3) what new laboratory and/or test equipment would be purchased as soon as possible. The information obtained is summarized in Table 3.

In addition, an inventory of laboratory and test equipment was obtained from each school. The school representative provided this information by completing the Laboratory and Test Equipment List (Appendix K). These inventories are presented in Table 4.

The purpose of obtaining this information was to determine if a pattern could be found to relate recent expenditures to expenditures which would be desirable. Conversations with the school spokesmen revealed that a great many variables influenced the amount and type of equipment bought, and thus the amount of money spent. Among these variables were:

1. The yearly proportion of the school's annual budget available to technical programs.

2. The magnitude of recent expenditures for such equipment.

TABLE 3

SUMMARY OF LABORATORY AND/OR TEST EQUIPMENT PURCHASED DURING 1967-68 AND 1968-69 SCHOOL YEARS, AND EQUIPMENT WHICH WILL BE PURCHASED AS SOON AS POSSIBLE[a]

School	Purchases During 1967-68	Cost[b]	Purchases During 1968-69	Cost	As Soon as Possible	Cost
A	9 scope[c] 20 trnstr trnr 20 trnstr T-rack 1 comptr fundamentals dem	50	12 VTVM 12 VOM 12 AC ma mtr	1.6	12 scope[c] 10 logic trnr 1 freq ctr 1 small dig comptr 10 AF gen	40
B	None	0	1 VTVM 2 scope	.92	2 scope[c] 4 scope 4 dig ckt dem	8
C	5 scope[c] 10 VTVM 10 AF gen 1 pulse gen	12		0	20 scope 1 small dig cmptr	6

[a] To conserve space the following abbreviations have been used throughout this table: AC--alternating current, AF--audio frequency, ant--antenna, ckt--circuit, ctr--counter, dem--demonstrator or demonstration, dig--digital, dis--distortion, elec--electronic, eqpt--equipment, expt--experiment, FM--frequency modulation, freq--frequency, gen--generator, lab--laboratory, ma--milliamp, meas--measuring or measurement, micwv--microwave, mtr--meter, pwrsup--power supply, scope--oscilloscope, sig--signal, trnr--trainer, trnstr--transistor, VM--voltmeter, VOM--volt-ohm meter, VTVM--vacuum tube voltmeter, Z--impedance.

[b] Costs are given in thousands of dollars. Figures for past purchases are approximate, and costs of equipment to be purchased as soon as possible are estimated.

[c] This indicates an instrument of very high quality with a wide range of functions and extreme sensitivity. Unless so designated, the instrument should be considered to be of lesser quality.

TABLE 3--Continued

School	Purchases During 1967-68	Cost[b]	Purchases During 1968-69	Cost	As Soon as Possible	Cost
D	None	0	10 VTVM 10 VOM 6 scope	2.5	Eqpt for making printed ckt boards	1
E[d]	None	0	None	0	All basic lab and/or test eqpt	25
F	2 scope[c] 1 trnstr curve tracer 2 analog cmptr 2 dig cmptr 3 micwv trnr	23.6	5 scope[c] 1 micwv trnr 3 pulse gen 5 pwrsup for student lab station 2 Z bridge 1 dig cmptr	25	1 dis analyzer 1 FM sig gen 15-20 VOM 10 basic elec ckt student kit	10
G	None	0	None	0	1 ant system 5-8 scope[c] 5-8 cross-bar gen sig strength meas eqpt chart and tape recording eqpt	30
H	None	0	All basic eqpt	Not given	None	0

[d]This program was begun during 1968-69. Equipment necessary to begin operation was leased.

TABLE 3--Continued

School	Purchases During 1967-68	Cost[b]	Purchases During 1968-69	Cost	As Soon as Possible	Cost
I	1 transmitter--receiver 1 dig cmptr and memory[c] 1 scope 1 trnstr curve display unit	6.2	1 dig VM 1 semiconductor curve tracer 7 pwrsup for trnstr experiments	2.1	1 dig cmptr and memory 10 trnstr VOM 2 pwrsup for trnstr experiments	5
J	3 basic trnstr expt system 28 pwrsup for student lab station 1 advanced trnstr expt station 2 radar and micwv ckt analysis systems 2 sets radar and micwv test eqpt 14 mtr panel	26.8	1 pulse gen 5 AC ma mtr 5 AF gen 4 scope	8	Dig cmptr training eqpt	20
K	Eqpt to convert student lab kits to trnstr	1.4	1 scope[c] 1 scope 4 core memory trnr	3.2	2-3 scope[c] 10 VTVM 10 VOM	10
L	All basic lab and/or test eqpt	150	None	0	1 dig VM 2 AC ma mtr	.55
M	4 AF gen 3 microammeter 10 VOM 1 tube tester 4 decade box 5 student kits	4	None	0	All kinds of lab and/or test eqpt	30

TABLE 3--Continued

School	Purchases During 1967-68	Cost[b]	Purchases During 1968-69	Cost	As Soon as Possible	Cost
N	All basic lab and/ or test eqpt	30	None	0	Dig cmptr trnr eqpt 1 dig VM 1 micwv dem 1 scope[c] Eqpt for making printed ckt boards	20
O	4 AF gen 6 VTVM	.6	Ultrasonic dem	.3	1 trnstr curve tracer 1 low freq gen 1 dig cmptr trnr	4
P	1 scope[c] 6 ma mtr 1 instrument current transformer	1.5	1 scope[c] with attachments	3	1 dig cmptr[e] Micwv dem and instructional eqpt	15
Q	1 elec ckt classroom dem	2.5	3 VTVM	.4	12 student lab kit 1 decade box 1 scope[c] 12 pwrsup for student lab stations	14
R	All basic lab and/ or test eqpt	75	2 scope[c] 15 scope 15 VOM 15 VTVM 15 AF gen 15 high-voltage pwrsup 15 low-voltage pwrsup	12.5	1 dig dem 1 dig cmptr Dig eqpt for student lab stations	20

[e]Tentative plans include rental of a computer at an estimated annual cost of $10,000.

TABLE 3--Continued

School	Purchases During 1967-68	Cost[b]	Purchases During 1968-69	Cost	As Soon as Possible	Cost
S	4 low-voltage pwrsup 3 scope[c] 1 dis analyzer	1.2	4 scope 4 AF gen	3.4	5 scope[c] 1 trnstr curve tracer 1 dig cmptr trnr	7.2

TABLE 4

INVENTORIES OF LABORATORY AND TEST EQUIPMENT AT SCHOOLS VISITED

Items	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S
VTVM	41	11	20	14	12	40	8	11	13	40	12	19	12	12	20	15	9	50	10
Ohmmeter	0	0	0	0	0	0	0	0	0	0	7	0	0	6	0	0	4	0	1
Multimeter	45	10	40	9	12	40	8	10	20	40	12	20	9	12	30	15	6	50	26
D-C Voltmeter	0	0	15	0	0	5	0	10	0	0	5	42	0	12	0	0	14	10	5
D-C Ammeter (Assorted Ranges)	0	10	10	6	12	40	0	20	20	0	50	26	0	14	10	50	16	60	29
A-C Ammeter (Assorted Ranges)	12	1	0	0	12	25	0	20	1	0	25	26	0	6	10	0	10	30	4
A-C Voltmeter	0	0	0	0	0	0	0	0	0	0	0	0	7	0	0	0	0	0	0
Thermocouple Meter	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	1	0	6	2
Galvonometer	1	0	2	2	12	1	0	1	10	0	6	0	0	6	2	2	5	6	2
Wattmeter	0	0	1	0	0	5	0	1	0	0	0	3	1	4	0	0	0	2	3
Impedance Meter	0	0	1	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0
Grid Dip Meter	6	0	2	0	0	2	4	1	5	5	1	1	0	1	2	1	0	5	1
Q Meter	0	0	1	0	0	0	0	0	1	0	0	0	0	0	0	0	0	1	0
VSWR Meter	0	0	1	0	0	2	0	1	0	1	0	1	0	2	0	1	0	2	1
Sound Level Meter	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	1	0
Distortion Meter	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1	2
Wavemeter	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	6	1
Frequency Meter	0	0	2	0	0	5	0	0	1	1	0	0	0	0	0	6	0	3	2

TABLE 4--Continued

Items	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S
	Schools																		
Digital Voltmeter	10	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Differential Voltmeter	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Precision A-C Voltmeter	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0
Precision D-C Voltmeter	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0
Decade Resistance Box	6	10	10	0	6	1	1	0	9	10	12	16	0	12	1	4	1	4	21
Decade Condenser	0	10	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Oscilloscope	33	12	30	14	12	50	9	11	16	50	14	22	5	14	24	20	10	60	10
Transistor Curve Tracer	0	0	1	0	0	1	0	0	1	1	0	1	0	0	0	0	0	1	2
Vacuum Tube Curve Tracer	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Tube Tester	1	2	0	2	1	0	2	1	1	3	1	3	1	3	1	3	4	6	1
Transistor Analyzer	1	1	2	1	0	4	1	1	2	1	1	2	1	1	0	1	1	3	0
Capacitor Tester	2	1	5	13	12	2	3	2	2	8	1	4	2	2	2	0	1	8	0
Signal Tracer	4	1	2	1	0	0	1	0	1	27	0	2	0	0	0	0	1	0	0
Audio Analyzer	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	2
Signal Generator	25	9	42	13	12	48	22	50	10	39	6	16	2	18	24	4	6	50	10
Marker Generator	1	0	0	0	0	0	1	10	0	6	1	1	1	1	0	1	2	0	3
Audio Signal Generator	24	9	10	0	0	0	0	10	0	8	0	0	1	0	0	6	1	55	13
Pulse Generator	0	0	1	0	0	5	0	0	2	0	1	1	0	1	0	2	0	2	3
Square Wave Generator	24	10	20	0	0	0	0	10	0	27	0	0	0	0	0	2	6	0	1
Linearity Generator	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	1	0
Color Bar Generator	1	0	5	0	1	0	0	1	0	6	1	1	0	1	0	1	1	2	0

TABLE 4--Continued

Items	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S
	Schools																		
R-F Generator	0	0	0	0	0	0	0	0	0	0	0	12	0	0	0	0	0	0	0
Test Oscillator	0	0	30	0	0	0	0	0	14	0	0	0	0	0	0	4	0	0	3
Kelvin Bridge	0	0	1	0	0	0	0	0	2	0	1	0	0	0	0	0	0	0	0
Impedance Bridge	2	1	1	0	0	0	0	0	3	1	1	1	0	1	1	1	0	1	3
A-C Bridge	0	0	1	0	0	0	0	0	0	0	0	0	0	0	1	0	0	1	1
Wheatstone Bridge	0	0	2	0	0	4	0	0	2	0	1	0	0	0	1	1	0	1	1
Isolation Transformer	10	0	15	6	12	20	2	20	10	40	20	16	0	1	1	4	0	50	10
Power Supply (0-400 volts, 100 MA)	24	11	10	0	12	20	0	10	10	40	12	26	2	12	40	4	3	50	31
Power Supply (0-30 volts, 250 MA)	24	4	10	2	12	25	0	20	10	40	12	26	0	12	2	15	5	0	24
Variac	0	0	5	2	12	5	2	10	6	20	10	50	2	12	1	2	1	50	11
Klystron Power Supply	0	0	0	0	0	3	0	0	0	6	0	1	0	0	0	2	0	4	1
Dry Cell	48	59	0	0	12	50	0	50	30	20	25	81	4	124	50	6	0	10	10
Standard Potential Cell	0	0	5	0	0	1	0	0	1	0	0	0	0	0	1	2	0	1	5
Potentiometer	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0
Transistor Experiment Kit	0	10	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Audio Amplifier	0	1	0	0	0	10	0	0	3	0	0	0	0	0	0	2	0	0	1
Video Amplifier	0	0	0	0	0	10	0	0	0	0	0	0	0	0	0	0	0	0	2
All Band Receiver	0	0	1	0	0	5	0	1	1	2	0	1	0	2	1	1	0	1	1

TABLE 4--Continued

Items	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S
	Schools																		
Transmitter	0	0	1	0	0	5	0	1	1	0	0	0	0	4	1	2	0	12	1
A-M, F-M Transmitter-Receiver	0	5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Speaker, with Enclosure	0	2	2	0	12	0	0	0	0	0	2	2	0	2	3	2	0	2	0
Microphone	10	11	1	0	0	20	2	1	1	3	6	1	0	6	4	4	0	6	3
Crystal Mount	0	0	0	0	0	20	0	0	5	0	0	0	0	0	4	0	0	4	1
Parabolic Antenna	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Dipole Antenna	0	0	1	0	0	0	0	1	0	0	0	0	0	1	6	3	0	2	0
Dummy Antenna	0	0	1	0	0	0	0	1	2	0	0	0	0	2	0	1	0	5	2
Waveguide	0	0	0	1	0	4	0	0	0	6	0	1	0	0	0	1	0	4	1
Waveguide Antenuator	0	0	0	1	0	2	0	0	0	6	0	1	0	1	0	1	0	4	1
Slide Screw Tuner	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
Tapping Key	0	0	0	0	0	0	1	0	0	0	0	0	0	0	25	0	0	3	0
Code Practice Oscillator	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0
A-F-C Unit	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Vacuum Tube Circuit Demonstrator	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0
Transistor Circuit Demonstrator	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0
Dynamic Receiver Demonstrator	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0
Digital Demonstrator	0	0	1	0	0	2	0	0	1	0	4	5	0	1	0	3	0	0	0

TABLE 4--Continued

Items	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S
	Schools																		
Analog Computer	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	1	0	0	1
Industrial Counter	0	0	1	0	0	5	0	0	0	0	0	0	0	1	1	4	0	0	3
Electronic Switch	0	2	0	0	0	0	1	0	0	0	0	0	0	6	0	0	0	0	0
Null Meter	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0
Amplifier and Null Detector	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0
Audio Microvolter	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0
Stroboscope	0	0	0	0	0	2	0	0	0	0	1	1	0	1	0	0	0	4	1
Bench Lamp	0	0	0	0	0	0	3	0	0	0	0	0	0	0	0	0	0	0	0

3. The attitude and philosophy of the person responsible for recommending purchases of equipment.

4. The ability and previous training of students entering the training program.

5. The amount of money appropriated by the state legislature for technical education.

6. The relative age of the electronic technology program.

7. The type of training desired of electronic technicians by nearby industries.

It was also observed that the variables mentioned above did not have equal effect at all schools. For these reasons it was impossible to identify a meaningful pattern concerning this data, and the table must be interpreted cautiously to avoid the drawing of inferences that would not be true.

Hand and shop tools.--An inventory of tools was obtained from each college by means of a Hand Tool and Shop Equipment List which the school spokesmen were asked to complete (Appendix J). These inventories are presented in Table 5.

School spokesmen were also asked to indicate what additional hand or shop tools were needed. The greatest apparent influence on data regarding tool inventories was the degree to which students were encouraged (or required)

TABLE 5

INVENTORIES OF HAND TOOLS AND SHOP EQUIPMENT AT SCHOOLS VISITED

Items	Schools																		
	A	B[a]	C	D	E	F	G	H	I	J[b]	K	L	M	N	O[a]	P[b]	Q	R	S[a]
Long-nose plier	48	15	25	16	12	0	6	10	10	2	2	16	9	12	20	0	10	65	2
Utility plier	0	15	25	4	4	0	8	10	10	2	0	16	0	12	20	0	0	17	2
Channel-lock plier	0	0	0	0	0	10	3	0	0	0	0	0	0	0	0	0	0	0	0
Tweezer	0	0	5	0	12	0	6	1	10	0	0	6	0	0	4	0	0	1	4
Diagonal cutter	48	15	25	26	12	0	8	10	10	2	2	16	12	12	20	0	10	51	2
Nail clipper	0	0	10	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Tin snip	0	0	2	0	0	2	2	2	4	4	0	8	0	0	2	1	0	1	2
Wire stripper	0	4	25	0	0	1	6	10	5	6	1	6	8	0	2	2	5	2	2
Combination square	0	0	2	1	0	10	0	2	2	4	0	2	0	0	2	2	0	2	0
Try square	0	0	2	0	0	0	0	0	0	1	0	4	0	0	0	2	0	0	0
Framing square	0	0	2	0	0	0	0	0	0	0	0	2	0	0	0	0	0	1	0
Flexible steel tape	0	1	2	0	0	0	1	2	5	2	0	0	0	0	3	0	0	2	0
Steel or wood rule	0	0	2	2	1	1	6	2	3	0	0	12	0	0	20	4	0	3	0
Compass	0	20	5	0	0	1	10	0	0	2	0	2	0	0	0	0	0	0	2
Divider	0	0	5	0	0	1	0	2	0	2	0	0	0	0	2	2	0	2	2

[a]Students are encouraged (not required) to furnish their own hand tools.

[b]Students are required to furnish their own hand tools.

TABLE 5--Continued

Items	A	B[a]	C	D	E	F	G	H	I	J[b]	K	L	M	N	O[a]	P[b]	Q	R	S[a]
	Schools																		
Caliper	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0
Micrometer	0	0	0	0	0	0	3	3	0	0	0	0	0	0	0	0	0	0	0
Ball peen hammer	0	1	5	0	0	15	4	2	4	2	0	6	0	4	2	2	2	5	2
Claw hammer	0	1	1	1	0	1	1	0	1	1	0	4	0	0	0	0	0	2	2
Soft-face hammer or mallet	0	0	0	0	0	0	3	0	0	0	0	0	0	0	0	4	0	0	0
Center punch	0	0	20	0	0	0	2	4	5	1	0	8	0	0	0	4	0	2	2
Prick punch	0	0	12	0	0	0	2	4	2	1	0	8	0	0	1	0	0	1	2
Starting (tapered) punch	0	0	5	0	0	0	1	0	2	0	0	8	0	0	2	2	0	0	0
Pin punch	0	0	5	0	0	0	4	0	2	0	0	0	0	0	2	0	0	4	0
Cold chisel, assorted	0	3	2	0	0	0	2	2	5	1	0	12	0	0	6	2	0	4	0
Miniature file set	0	1	2	0	0	0	0	1	10	1	0	4	0	0	1	0	0	1	0
Mill file, approx. 10"	0	1	5	1	0	0	3	4	10	20	0	4	0	0	4	2	0	0	3
Square file	0	0	2	0	0	6	2	2	10	5	0	14	0	0	4	1	0	7	0
Round file	0	0	5	0	0	0	2	2	10	5	0	0	0	6	4	2	0	2	1
Triangular file	0	1	25	0	0	0	2	0	10	5	0	0	0	0	3	2	0	5	0
Open end wrench set	0	1	2	0	0	10	2	1	1	1	0	2	0	0	1	0	0	2	0
Adjustable wrench	0	2	25	0	12	9	8	12	5	4	3	16	0	0	2	2	0	2	2
Socket set	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	1	0	0	0

TABLE 5--Continued

Items	A	B[a]	C	D	E	F	G	H	I	J[b]	K	L	M	N	O[a]	P[b]	Q	R	S[a]
"Vise Grip" wrench	0	1	0	0	0	0	4	0	0	1	0	0	0	0	0	0	0	1	0
Screwdriver, slotted, assorted sizes	40	40	50	38	24	0	2	30	30	6	17	36	34	36	25	12	10	112	10
Offset screwdriver	0	0	20	0	0	0	2	10	10	1	0	0	0	0	2	0	0	0	0
Phillips screwdriver	40	5	25	6	12	0	15	20	10	2	7	20	23	12	4	6	10	4	10
Allen Hex screwdriver set	1	1	25	0	0	0	10	10	10	1	1	8	0	0	20	2	0	3	1
Jeweler's screwdriver set	0	1	1	0	0	0	2	0	0	0	0	1	0	0	2	2	0	1	1
Nut driver set	10	15	10	8	12	0	10	2	3	1	0	4	13	12	2	10	10	6	2
Alignment tool set	4	4	1	0	0	0	2	10	4	2	0	1	1	12	2	4	0	1	1
Hand drill	0	1	1	0	0	0	0	0	1	2	0	8	0	8	2	0	0	0	0
Masonry drill set	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	4	0
Repairman's reamer	0	0	0	0	0	0	5	0	0	0	0	0	1	0	0	0	0	1	0
Tap and die set	0	1	2	0	0	0	6	1	1	0	0	2	0	0	2	2	0	1	0
Hack saw frame	C	1	1	2	0	13	5	2	2	6	0	4	0	0	2	2	0	3	2
Hole saws, set	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0
Square hole punch set	0	0	0	0	0	0	6	5	10	1	0	2	0	0	1	0	0	1	1
Hand grinder	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0
Soldering gun	48	9	25	2	4	0	8	2	10	6	8	16	8	12	2	15	6	35	10
Soldering iron	0	0	15	10	1	0	0	5	10	1	0	16	0	2	20	0	0	9	10

TABLE 5--Continued

Items	A	B[a]	C	D	E	F	G	H	I	J[b]	K	L	M	N	O[a]	P[b]	Q	R	S[a]
	Schools																		
Soldering pencil	20	9	20	0	12	0	9	5	0	70	10	5	11	0	5	12	1	30	4
Soldering aid	0	0	0	0	12	0	0	0	0	0	0	0	24	0	0	0	0	0	0
Soldering brush	0	0	0	0	12	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Portable electric drill, 1/4" or 3/8"	0	1	1	2	0	0	6	1	2	2	0	1	1	0	2	1	0	2	1
Reciprocating saw, electric	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0
Bench grinder	0	1	1	0	0	1	1	0	1	2	0	0	0	0	0	0	0	1	0
Drill press, 1/2" chuck	0	1	1	0	0	2	0	1	1	2	0	0	0	0	1	1	0	1	0
Jig saw	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Band saw	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0
Lathe, small (1/2" stock)	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1	0
Box and pan brake	0	0	1	0	0	1	0	0	1	0	0	0	0	0	0	0	0	0	1
Nibbling tool	0	0	0	0	0	1	6	0	0	0	0	0	0	0	0	0	0	1	0
Turret punch	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0
Notcher	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0
Shear, 24"	0	0	0	0	0	1	0	0	1	0	0	0	0	0	0	0	0	1	0
Shear for printed circuit board	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1

TABLE 5--Continued

Items	Schools																		
	A	B[a]	C	D	E	F	G	H	I	J[b]	K	L	M	N	O[a]	P[b]	Q	R	S[a]
Hand riveter	0	0	0	0	0	0	3	0	0	0	0	0	0	0	0	0	0	2	0
Bench vise	0	2	4	0	0	7	4	0	3	4	0	8	0	0	2	2	1	2	1
Conduit bender	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Conduit cutter	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Propane torch	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	1	0
Wire brush	0	0	1	0	0	2	2	10	1	3	0	4	0	0	0	2	0	3	0
Bench brush	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0
Coil winder	0	0	0	0	0	0	3	0	0	0	0	0	0	0	0	0	0	0	0
Solderless terminal set	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0
Flaring tool set	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0
Staple gun set	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0

to buy their own tools. No problems regarding hand tools were apparent at any of the programs visited. Table 6 summarizes data concerning additional tools needed by each school.

TABLE 6

SUMMARY OF ADDITIONAL HAND AND SHOP TOOLS NEEDED AT SCHOOLS VISITED

School	Items Needed	Comments
A	None	
B	20 soldering pencils	
C	All items to equip additional student work stations	Student enrollment is eight times as large as two years ago.
D	20 soldering pencils	
E	None	
F	None	A greater need is for basic components--coils, resistors, relays, etc.
G	Drill press, power hand tools, spot welder, sheet metal equipment	Additional needs include components such as cable lacing ties, terminal strips, etc.
H	Small amounts of various hand tools	Replacement items are needed for tools broken or worn out through use from year to year.
I	None	

TABLE 6--Continued

School	Items Needed	Comments
J	None	
K	None	
L	None	Future needs include tools for a fabrication course which will be added.
M	Drill press	
N	Drill press, vises, various small hand tools	
C	None	Students are encouraged (not required) to buy their own hand tools.
P	None	Students furnish their own hand tools.
Q	None	New student tool kits were purchased for the 1968-69 school year.
R	None	A back-up supply is available.
S	Drill press	Students furnish most of their own hand tools.

Equipment thought most important for an electronic technician to be able to operate well.--During each interview, school representatives were asked to list two or three items of electronic equipment which an electronic technician should be able to operate well. The same information was elicited from industrial respondents on the final page of the Information Form (Appendix H). Both industrial and school personnel listed the oscilloscope most frequently, followed by common test meters such as volt-ohm meters and vacuum tube voltmeters. Signal generating equipment was the third most frequent choice. Table 7 depicts the school responses to this question. Information from industry is presented in Table 8.

TABLE 7

ITEMS OF EQUIPMENT LISTED BY NINETEEN SCHOOL REPRESENTATIVES AS BEING MOST IMPORTANT FOR AN ELECTRONIC TECHNICIAN TO BE ABLE TO OPERATE WELL

Items	Number of persons who mentioned the item
Oscilloscope	19
Vacuum tube voltmeter.	12
Volt-ohm meter	8
Signal generator (various types)	6
Multimeter	3
Digital voltmeter.	2
Pulse or frequency counter	2
Curve tracer	1
Bridge	1
Computer (used as test instrument)	1

The general agreement between school and industrial responses was interpreted as an indication that teachers in electronic technology programs are aware of the needs and preferences of employers in this respect. While many more items were mentioned by industrial respondents, the items they mentioned most frequently were the same as the items most frequently listed during school interviews.

Specialized needs of various industries were also apparent. The broadcast industry listed "transmitters" twenty-one times, "distortion analyzers" eleven times, "video equipment" nine times, and "audio amplifiers" seven times. "Frequency counter" was listed seven times by research/testing laboratories. More than sixty other items of equipment were named three or fewer times within an industrial group. Because these items were mentioned by only one industry, they were not tabulated.

TABLE 8

ITEMS OF EQUIPMENT LISTED BY INDUSTRIAL REPRESENTATIVES AS BEING MOST IMPORTANT FOR AN ELECTRONIC TECHNICIAN TO BE ABLE TO OPERATE WELL

Items	Number of times listed by: Research Labs	Manufacturers	Broadcasters	Telephone Companies
Oscilloscope	66	15	42	4
Multimeter	23	2	18	5
Vacuum tube voltmeter.	15	3	18	5
Volt-ohm meter . . .	15	7	15	2
Impedance matching devices (bridge) .	12	3	3	2
Signal generator . .	14	5	9	1
Soldering iron . . .	9	2	4	1
Pulse measuring equipment or pulse generator.	9	0	1	1

<u>General trend of curriculum change</u>.--At each school visited, the spokesman was asked what new courses were added this year and last year, and if a general change concerning all or part of the electronic technology program was being attempted. Information given in response to these questions is summarized in Table 9.

Major changes of emphasis at all schools were toward instruction in solid state electronics. Provisions were being made (or had already been made) to include instruction about integrated circuits, digital computers, and other new electronic devices. The consensus in regard to curriculum change was that vacuum tubes have become less important than solid state devices.

<u>Staff development</u>.--School spokesmen were asked about their opportunities for professional development. One of the colleges visited maintained a sabbatical leave policy, and three school representatives reported that leaves of absence were available to staff members who wanted to attend graduate school during the regular school term. Every school visited offered financial incentive to teachers who increased their level of professional training. Salary increments were based on achievement of a higher degree or completion of a specified number of hours toward a higher degree.

TABLE 9

SUMMARY OF COURSES ADDED AND CHANGES OF EMPHASIS AT THE NINETEEN SCHOOLS

School	Courses Added During 1967-68	Courses Added During 1968-69	Changes of Emphasis Being Attempted
A	1. Fundamentals of digital computers (mostly theory, no equipment to provide applications)	None	Major revision of all courses has already been done--formerly 85% tubes, 15% transistors, now almost a complete reverse
B	None	None	Shift emphasis toward pulse counters and specialized industrial electronics, plus general change from tubes to solid state
C	1. Applied technical math (applications of Integral Calculus, Statistics and various other concepts)	1. Microwave Systems 2. Telemetry Systems 3. Computer Systems for Process Control	Emphasis on digital applications--to meet demand of employers
D	None	None	Some "electrical trades" courses have been changed to more emphasis in electronics

TABLE 9 --Continued

School	Courses Added During 1967-68	Courses Added During 1968-69	Changes of Emphasis Being Attempted
E	----	Program in first year of operation	Emphasis toward maintenance of computer-controlled equipment in local plants
F	None	None	Working toward establishment of courses in sound analysis, a course totally concerned with integrated circuits, and an advanced course in electronic communication.
G	None	Introductory electronics course for general elective by any student on campus	Attempting to obtain equipment to allow more concentration in microwave
H	----	Program in first year of operation	None

TABLE 9 --Continued

School	Courses Added During 1967-68	Courses Added During 1968-69	Changes of Emphasis Being Attempted
I	1. Introduction to computers 2. Introduction to new electronic devices 3. Test instruments and measurements	None	More emphasis in math
J	None	1. Radio and TV repair 2. Circuits and systems 3. Instrumentation	Attempting to provide more opportunity for students to specialize, as in microwave, digital circuits, etc.
K	None	None	None. Emphasis already shifted to "solid state" and digital
L	None	Introduction to electronics (survey-type course)	Emphasize transistors and integrated circuits
M	Program in first year of operation	None	None
N	None	None	Strengthen computer content, emphasize "solid state"

TABLE 9 --Continued

School	Courses Added During 1967-68	Courses Added During 1968-69	Changes of Emphasis Being Attempted
O	Over the 1967-68 and 1968-69 school years, no courses have been added. However, courses have been revised and re-written to include more emphasis on "solid state."		Emphasize integrated circuits and "solid state"
P	None	Combined some courses to make a 4-semester program instead of 5-semester	Strengthen computer content
Q	None	None	More concentration in transistor devices
R	1. Digital electronics 2. Precision measurement	None	Strengthen instrumentation courses and provide students more background in math
S	Re-wrote entire curriculum	1. Applied differential equations	Emphasize "solid state," integrated circuits, and DC coupling devices

Industrial experience.--Because work experience in industry is highly desirable for teachers in technical programs, each of the school representatives interviewed was asked about the industrial experience of staff members at his school. The questions asked at each school were:

1. How long has it been since your teachers had the opportunity to work in industry?

2. What should be the minimum amount of industrial experience required of teachers in electronic technology programs?

In response to these questions a majority of school spokesmen expressed the opinion that in the field of electronics, time elapsed since industrial experience is as important as amount of industrial experience. Opinions were varied concerning the amount of industrial experience which should be required. Most of the persons interviewed gave qualified answers, expressed in terms of more than one criterion. Among the comments and opinions expressed were:

1. "Five years." (6)[1]
2. "Depends on the industry." (4)
3. "Depends on the man and the experience." (3)
4. "The more the better." (2)

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[1]The number of times the comment was made is in parentheses following the remark.

5. "Three to four years." (2)

6. "Three to six years of <u>varied</u> experience." (2)

7. "Three years minimum." (2)

8. "Three to five years." (1)

9. "Three to five years, with a bachelor's <u>or</u> associate degree." (1)

10. "Two years in research and development." (1)

11. "The experience should include working with technicians." (1)

12. "State plan is satisfactory." (1)

13. "One and one-half to two years, and accept good military experience." (1)

14. "Don't know if a minimum should be required." (1)

15. "May not be required if the man has an engineering or physics degree." (1)

16. "May not be required if the man is a good teacher." (1)

From these statements it was concluded that most of the persons who were interviewed shared the opinion that industrial experience was desirable for teachers in electronic technology. They were not in agreement that it was absolutely necessary. They were concerned that experience in industry should be of a type that would enhance the teacher's ability to teach technicians. As a group, the men interviewed were not favorably inclined toward a policy of requiring industrial experience unless consideration was also given to the type of experience.

Reactions to week-end in-service training.--At each college visited, the school's representative was asked if he thought a week-end in-service training program would be of any value in helping the teachers on his staff keep abreast of industrial developments. Answers from the nineteen school representatives were as follows: (1) two answered "yes," (2) four answered "yes" but qualified their answers, and (3) thirteen persons answered "no."

General reaction to the suggestion of in-service training on week-ends included (1) aversion to the transportation problem which would result if teachers were expected to travel to another city to attend a week-end session, and (2) agreement that a week-end was too short a time. The nineteen spokesmen interviewed were generally agreed that a program of summer employment in cooperation with industry would be more satisfactory. Their reasons for favoring a summer program included:

1. A summer would provide adequate time for learning effectively and for becoming proficient with new types of equipment. A week-end or a series of week-ends would not.

2. Sixteen of the nineteen persons interviewed reported that their normal term of employment was the nine-month academic year. Summer was seen by these

teachers as the obvious time during which to schedule in-service training.

The possibility of an institute-type summer program in cooperation with industry was also suggested by several school spokesmen. This suggestion included the stipulation that completion of such a program should earn participants a certain number of hours of graduate credit or that credit earned should be equally applicable with graduate credit toward increments in pay. The spokesmen justified this stipulation on the basis that completion of this type of advanced instruction in electronics would make as great a contribution toward professional development as completion of non-technical graduate credit toward a higher degree.

Accumulation of floor plans.--An attempt was made to obtain floor plans of laboratories and classrooms used by the electronic technology departments of participating colleges. Seven schools were able to provide these drawings. The plans which were obtained appear in Appendix R.

In presenting floor plans of facilities they were presently using, a majority of the college spokesmen commented that a work area exclusively for staff use should be made available. A preferred arrangement was to have such an area set aside in a large storeroom or stockroom. The principal advantage expressed for this arrangement was that work could be left partially completed without fear of its being disturbed. It was also observed that teachers at schools with such a work area were utilizing it for purposes directly related to classroom instruction. Among the types of work which were actually in progress were:

1. Preparation of audio-visual aids, such as transparencies and 35mm slides.

2. Testing, adjustment, and repair of instruments which had been damaged.

3. Evaluation of students' work through testing of completed circuits such as amplifiers.

4. Building of prototype models to evaluate their suitability for use as laboratory exercises which might be required of students.

Data Collected From the Information Form

The Information Form was used to gather data from schools and industries concerning the electronic technology curriculum. It also served to collect data from industries concerning the number of technicians employed and additional technicians needed, the sources from which presently employed technicians received their training, and other general information about the training and hiring of technicians. The data concerning the curriculum was analyzed by the Texas A&M University Data Processing Center. Information from industry concerning the employment of technicians was summarized and prepared for presentation manually.

Acceptance or rejection of data.--Many of the returned Information Forms were completed according to the instructions provided, with the exception that some items were omitted. These omissions occurred throughout the Information Form, both in the section devoted to curriculum and on the last page, which was devoted to information about the training and hiring of technicians. The omissions occurred in a random pattern.

In order to make use of the information which was on these questionnaires, it was necessary to establish policies governing items which had been omitted. A statistician was consulted, and based on his suggestions the following policies were established:

1. Within the curriculum section, responses concerning desired teaching emphasis and estimated future importance were considered separately. Under this policy the responses concerning desired teaching emphasis might be used while the responses concerning future importance might not be used, for the same questionnaire. (The reverse of this situation might also be true.) The design

of the curriculum section made this possible. Replies indicating desired teaching emphasis were independent of replies estimating future importance because the two kinds of responses were made in separate sets of multiple columns.

2. Special consideration was given to the curriculum section with regard to the possibility that isolated units might have been accidentally omitted by the person completing the questionnaire. This might be due to momentary indecision or simple oversight while checking the many items. It was estimated that these two possibilities were about equally likely to occur; and that regardless of which one actually did occur, responses to items which were checked should not be disregarded.

It was desirable to treat these omissions in some manner which would be acceptable to an existing computer program. This would save the time and expense of writing a more complicated program and trial runs to edit and revise it if necessary.

The policy selected was to decide upon a critical number of items an individual might accidentally omit while completing the Information Form. Questionnaires with more than that number of omissions were rejected. Omissions in questionnaires with fewer than the critical number of omissions were assigned the least critical response, <u>under the assumption that the person who completed the questionnaire would have given a more important or more critical rating immediately if he had felt the unit was sufficiently important</u>.

Thirty was selected as the critical number. Questionnaires with thirty omissions or more were rejected as being too incomplete to be considered valid. Questionnaires with twenty-nine or fewer omissions were treated as described. The critical number, thirty, represented 7.10 per cent of the 421 possible responses.

3. The five pages of the Information Form pertaining to the curriculum and the last page which contained information about employment and training of technicians were treated separately. Under this policy, a particular questionnaire might be discarded insofar as response to the curriculum was concerned, but considered valid concerning the information on the last page. The reverse of this situation was also possible if the last page was omitted entirely.

4. With regard to the "General Information" on the last page, any response was considered valid. The basis for this was that the items were not necessarily interdependent--any question might be answered legitimately without regard to any other on the page.

Implementation of these policies resulted in rejection of certain data within the curriculum section of the Information Form. Table 10 summarizes the number of usable responses from industry. Usable information pertaining to required teaching emphasis was obtained from all nineteen school representatives. However, only fifteen school spokesmen (78.9 per cent) supplied estimates of the future importance of each unit.

TABLE 10

NUMBER OF RETURNED QUESTIONNAIRES COMPARED TO NUMBER WHICH WERE USABLE

Industrial Group	Number of Forms Returned	Number Usable Regarding Teaching Emphasis	Number Usable Regarding Estimates of Future Importance[a]
Research Laboratories	84	78 (92.9%)	71 (84.5%)
Telephone Companies	26	21 (80.8%)	17 (65.4%)
Commercial Broadcasters	77	59 (76.6%)	55 (71.4%)
Manufacturers	21	15 (71.4%)	12 (57.1%)
Totals	208	173 (83.2%)	155 (74.5%)

[a]The statistical analysis concerning future importance of each unit involved only the total number in this column, 155. Usable returns from each industrial group are significant only because they show how the total was derived.

Analysis of data concerning the curriculum.--The statistical method used to treat the curriculum data was the chi-square test of independence of two variables. Using this method, the three null hypotheses were tested for each of the 421 instructional units listed in the Information Form. Values of chi-square were calculated according to the general formula:

$$\chi^2 = \sum \frac{(O-E)^2}{E} ,$$

where O = the observed frequency in each cell of the contingency table and E = the expected frequency for each cell based on probability.[2]

This technique required that three contingency tables be generated for each of the 421 units--one table to test each of the three hypotheses. All hypotheses were accepted or rejected at the .05 confidence level.

Significant differences in teaching emphasis indicated by schools and industries.--The first hypothesis, that there would be no significant difference in the degree of teaching emphasis indicated necessary for each unit by school and industrial raters, was rejected for 192

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[2]George A. Ferguson, Statistical Analysis in Psychology and Education (New York: McGraw-Hill Book Company, Inc., 1959), p. 166-67.

units. An example of the contingency table generated to test this hypothesis for each unit is shown below:

Variable 2: Emphasis

Variable 1: Source	Taught in Depth	Empha-sized	Dis-cussed Briefly	Not Taught	Totals
Schools (group 1)					
Industries (groups 2, 3, 4)					
Totals					

Using a 2 X 4 contingency table, a calculated chi-square value greater than 7.82 is sufficient for rejection of a hypothesis at the .05 level.[3] Chi-square values associated with such tables have three degrees of freedom.[4]

The units for which this hypothesis was rejected are listed below, in the same order as they appear on the Information Form. The format of the list includes all major divisions and subdivisions used in the Information Form. Instructional units for which the hypothesis was accepted are not listed. The word "none" following a subdivision title indicates that the hypothesis was not rejected for any of the units in that subdivision.

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[3]Ferguson, Statistical Analysis, p. 309.

[4]Ibid., p. 168.

Significant Units: #1

DIRECT CURRENT

Basic Principles

None

Network Laws (A-C and/or D-C)

Kirchhoff's laws
Thevenin's theorem

ALTERNATING CURRENT

Basic Principles

None

Vectors and Phase Relationships

Complex numbers (J operator)
Polar coordinates

Transformers

Impedance matching
Three-phase (delta and wye connections)

TEST EQUIPMENT

Meter and Generator Usage

Basic meter movements
Transistor voltmeters
Multimeters
Ohmmeters
Storage oscilloscopes
Laboratory oscilloscopes
Wavemeters
Impedance bridge
A-C bridge
Transistor curve tracers
X-Y plotters
Frequency meter
Sine-wave generators
Signal generators (a-f and r-f)
Pulse generator
Sweep generator

Linearity generator
Time mark generator
Time domain reflectometer
Color bar generator
Stroboscope
Nuclear instruments

INDUCTANCE AND CAPACITANCE

Inductance

Inductive reactance
Instantaneous current analysis
Q of a coil

Capacitance

Effects in D-C circuits
Capacitive reactance

R-L-C Circuits

Series R-L-C circuits
Parallel R-L-C circuits

Parallel, Series Resonant Circuits

Resonant circuit "Q"
Analysis of series and parallel resonant circuits
Resonant circuit bandwidth
Applications of resonant circuits
Frequency response curves
Resonant filters

VACUUM TUBES

Fundamentals

Types of emission

Diodes

Characteristic curves
Rectification, detection

Triodes

Biasing methods, positive and negative
Load lines
Saturation

Interelectrode capacitance
Transconductance, plate resistance, amplification factor
Static and dynamic characteristic curves
Transfer curves
Voltage amplification

Tetrodes

Plate and screen characteristic curves

Pentodes

Effects of suppressor grid
Plate and dynamic characteristic curves
Tube parameters

Multigrid Tubes

None

Special Application Tubes

Photo-multiplier tubes
Cathode-ray tubes

SEMICONDUCTORS

Fundamentals

Atomic structure
Crystal structure
Bonds
Impurities
Electrons and hole charges

Semiconductor Diodes

PN junctions
Forward and reverse bias
Characteristic curves
Variable-capacitance diodes
Hall generators

TRANSISTORS

Construction and Characteristics

Configurations
Current gain

Static characteristic curves
Dynamic transfer curves
Transistor biasing
Physical circuit operation (NPN and PNP)
Load lines
Graphical analysis
Operating point
"R" parameter

Special Purpose Transistors

Microcircuits (including integrated circuits)

BASIC CIRCUITS AND SYSTEMS

Power Supplies

Half and full wave rectifiers
Principles of filtering
Polyphase power supplies
R-F power supplies

Amplifier Fundamentals

Magnetic amplifiers
Frequency response

Basic Vacuum Tube Amplifiers and Circuits

Paraphase amplifiers
Amplifier coupling
Bandpass amplifier circuits

Loudspeakers

None

Microphones and Pickups

None

Oscillators

Phase-shift oscillators
Tuned plate-grid oscillators
Hartley oscillators
Colpitts oscillators
Armstrong oscillators
Electron-coupled oscillators
Crystal overtone oscillators

R-F Amplifiers and Circuits

R-F amplifier circuits (general)
R-F power amplifiers
Wide-band amplifiers
Single and double tuned circuits

Transmitter Fundamentals

C-W transmitter keying
Classification of wave emission
Power distribution in a-m wave

Radio Transmitters and Circuits

C-W transmitters
A-M transmitters and circuits

Transmission of Radio Waves

None

Radio Receiver Fundamentals

Heterodyning principles
A-M detection
F-M detection
Alignment procedures

Radio Receivers and Circuits

Superhet receivers (general)
AM-FM receivers
Sideband receivers
AVC circuits
The B+ supply
Limiters
Discriminators

TRANSISTOR CIRCUITS

Transistor Amplifier Fundamentals

Input and output resistance
Effects of feedback

Transistor Amplifiers and Circuits

Common emitter, collector, and base configurations

Transformer coupled amplifiers
Reflex amplifiers

Transistor Receivers

None

ADVANCED CIRCUITS AND SYSTEMS

Nonsinusoidal Waveshapes

Square waves
Rectangular waves
Sawtooth waves
Triangular and peaked waves
Curved wave forms
Transients
D-C components of waveforms
A-C components of waveforms
Waveform generation

Pulse and Switching Circuits

Diode and triode switching circuits
Free running multivibrators
Bistable multivibrators
Monostable multivibrators
Astable multivibrators
Blocking oscillators
Shock-excited oscillators
Gas-tube relaxation oscillators
Gating circuits
Delay circuits
Saturable-core reactor circuits
Binary systems
Null detectors

Digital Computer Fundamentals

None

Limiters, Clampers, Counters

Diode limiters
Triode limiters
Diode clamping
Counters (frequency divider)
Diode clippers

Sweep-Generator Circuits

Sawtooth-wave form circuits
Gas-tube sweep generator circuits
Transistor sweep generator circuits

TV Transmitters and Receivers

None

MICROWAVE ELECTRONICS

Microwave Transmission

Communications transmitters
Radar transmitters

Special Amplifiers

Video amplifiers
D-C amplifiers
Traveling-wave amplifiers
Masers
Lasers

Miscellaneous (Microwave)

Microwave mixers

Microwave Receivers

None

Multiplexing

Time-division multiplexing principles
Time-division multiplex transmitter and receiver analysis
Frequency-division multiplexing principles
Frequency-division multiplex transmitter and receiver analysis

Microwave Measurements

Attenuation measurements
Power measurements
Reflectometer measurements
Noise measurements
Dielectric measurements

Radar System Principles

Block diagram analysis
Radar sweep chains
Range-mark generator chains
Delay devices in radar systems
Radar modulators

Navigational Electronics

None

OTHER APPLICATIONS OF ELECTRONIC DEVICES

Generators and Motors (Types and Theory)

Three-phase principles
Converters, inverters, and dynamotors
Generator and motor maintenance
Speed regulators

Synchros and Control Systems

Differential synchro
Synchro control transformer
Synchro capacitors
Synchro connections

Servo Control Devices and Systems

Servomechanism chains
Frequency response of servo systems

Industrial Electronic Applications and Devices

Decision or intelligence devices
Simple electronic circuits
Ultrasonics
Transducers
Thermistors
Varistors
Time-delay relays
High-speed light and register controls
Electronic timer circuits
Photoelectric devices

Significant differences in teaching emphasis indicated by different industries.--Each instructional unit was also tested against a second hypothesis--that there would be no significant difference in the degree of teaching emphasis indicated necessary for each unit by raters from different industries. This hypothesis was rejected for 227 instructional units.

Contingency tables generated to test this hypothesis were in the format shown on the next page. For a 4 X 4 table such as this, there are nine degrees of freedom.[5] The critical value for rejection of a hypothesis at the .05 level under these conditions is 16.92.[6]

For this series of contingency tables, group three (the communications industry) was treated as two groups in order to provide a more meaningful test. This was easily done. When the cooperating companies of group three were numbered, telephone companies were assigned numbers up to fifty. Commercial broadcasters were assigned numbers beginning with fifty-one. The two kinds of companies within the group were easily identified on the basis of the assigned number.

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[5]Ferguson, Statistical Analysis, p. 168.

[6]Ibid., p. 309.

Variable 2: Emphasis

Variable 1: Source	Taught in Depth	Empha-sized	Dis-cussed Briefly	Not Taught	Totals
Research or Testing Labs (group 2)					
Communications Industry (group 3) (telephone companies)					
Communications Industry (group 3) (commercial broadcasters)					
Manufacturers (group 4)					
Totals					

Units for which the hypothesis was rejected are listed below. The units are listed in the same order as in the Information Form. The list follows the same format as the list of units for which the first hypothesis was rejected.

Significant Units: #2

DIRECT CURRENT

Basic Principles

Batteries

Network Laws (A-C and/or D-C)

None

ALTERNATING CURRENT

Basic Principles

None

Vectors and Phase Relationships

Vectors and vector diagrams
Instantaneous values
Phase relationships
Complex numbers (J operator)
Polar coordinates

Transformers

Transformer losses and ratios
Frequency response

TEST EQUIPMENT

Meter and Genrator Usage

Ohmeters
Wavemeters
Impedance bridge
A-C bridge
Wattmeter
Transistor analyzers
Frequency meter
Sweep generator
Time mark generator
Color bar generator

INDUCTANCE AND CAPACITANCE

Inductance

A-F and R-F chokes
Q of a coil

Capacitance

Effects in D-C circuits
Bypass capacitor effect

R-L-C Circuits

None

Parallel, Series Resonant Circuits

Applications of resonant circuits
Frequency response curves
Resonant filters

VACUUM TUBES

Fundamentals

Types of envelopes and bases
Cathodes; directly and indirectly heated

Diodes

Characteristic curves
Rectification, detection

Triodes

Biasing methods, positive and negative
Load lines
Saturation
Interelectrode capacitance
Transconductance, plate resistance, amplification factor
Transfer curves
Voltage amplification
Equivalent circuits

Tetrodes

Interelectrode capacitance
Effect of screen grid
Effects of secondary emission
Plate and screen characteristic curves

Pentodes

Effects of suppressor grid
Plate and dynamic characteristic curves
Tube parameters
Sharp and remote cutoff characteristics
Beam power tubes

Multigrid Tubes

Pentagrid converters
Pentagrid mixers

Special Application Tubes

Multisection tubes
Subminiature tubes
Gas-filled regulators
Ignitrons
High frequency tubes
Klystrons

SEMICONDUCTORS

Fundamentals

None

Semiconductor Diodes

None

TRANSISTORS

Construction and Characteristics

Transistor fabrication
Load lines
Graphical analysis
"R" parameter
Hybrid parameters

Special Purpose Transistors

Tetrode transistors
Unijunction transistors
Microcircuits (including integrated circuits)

BASIC CIRCUITS AND SYSTEMS

Power Supplies

R-F power supplies

Amplifier Fundamentals

Decibels
Stereophonic sound
Frequency response

Basic Vacuum Tube Amplifiers and Circuits

Paraphase amplifiers

Push-pull a-f amplifiers
I-F amplifiers
Amplifier coupling
Audio preamplifier circuits
Audio-output stage
Tone control circuits
Bandpass amplifier circuits
Attenuators
Delayed-action circuits

Loudspeakers

Headsets
Dynamic speakers
Electrostatic speakers
P-M speakers
Speaker enclosures

Microphones and Pickups

Carbon
Capacitor
Crystal
Dynamic
Velocity
Ceramic

Oscillators

Tuned plate-grid oscillators
Electron-coupled oscillators
Crystal overtone oscillators

R-F Amplifiers and Circuits

R-F amplifier circuits (general)
R-F power amplifiers
Wide-band amplifiers
Single and double tuned circuits
Neutralizing circuits
R-F buffer and frequency multipliers
Troubleshooting procedures

Transmitter Fundamentals

C-W transmitter keying
Classification of wave emission
Parasitics and harmonics
Power distribution in a-m wave
Transmitter measurements

A-M, F-M comparisons
Transmitter alignment

Radio Transmitters and Circuits

C-W transmitters
VHF transmitters
UHF transmitters
A-M transmitters and circuits
Sideband transmitters
F-M (reactance tube) transmitters
F-M (phase) transmitters
Troubleshooting procedures

Transmission of Radio Waves

Principles of radiation and propagation
Antenna fundamentals
Transmission line theory
Types of antennas
FCC regulations

Radio Receiver Fundamentals

Reading schematic diagrams
Heterodyning principles
A-M detection
F-M detection
Alignment procedures
Troubleshooting procedures

Radio Receivers and Circuits

T-R-F receivers
Superhet receivers (general)
AM-FM receivers
Sideband receivers
Special receiver circuits
AVC circuits
The B+ supply
Squelch circuits
Limiters
Discriminators

TRANSISTOR CIRCUITS

Transistor Amplifier Fundamentals

Reading transistor specifications
Volume and tone controls

Transistor Amplifiers and Circuits

R-F and I-F amplifiers
Wide-band amplifiers
Preamplifiers
Symmetry circuits

Transistor Receivers

None

ADVANCED CIRCUITS AND SYSTEMS

Nonsinusoidal Waveshapes

Square waves
Rectangular waves
Sawtooth waves
Triangular and peaked waves
Multi-segmented waves
Curved wave forms
Transients
D-C components of waveforms
A-C components of waveforms
Waveform generation

Pulse and Switching Circuits

Astable multivibrators
Pulse generators
Pulse counters
Logic circuits
Pulse amplifiers
Binary systems
Decimal systems

Digital Computer Fundamentals

Computer applications
Computer programming
Computer math
Adders and subtractors
Methods of data storage
Analog-to-digital conversion

Limiters, Clampers, Counters

Triode limiters
Counters (frequency divider)
Diode clippers

Sweep-Generator Circuits

Sawtooth-wave form circuits
Gas-tube sweep generator circuits
Transistor sweep generator circuits
Sweep expansion and delay circuits

TV Transmitters and Receivers

Frequency bands
Standard interlaced scanning
Composite TV picture signal
Camera tubes
TV image and image resolution
TV transmitter functional analysis
TV receiver functional analysis

MICROWAVE ELECTRONICS

Microwave Transmission

Communications transmitters
Radar transmitters
Generating microwave signals
Cavity resonators
Waveguides
Duplexers
Microwave antennas
Transmission lines
Wavelength measurement

Special Amplifiers

Grounded-grid amplifiers
Video amplifiers
D-C amplifiers
Traveling-wave amplifiers
Parametric amplifiers
Masers
Lasers

Miscellaneous (Microwave)

Backward-wave oscillators
Microwave mixers
Using Smith chart

Microwave Receivers

Communications receiver

Radar receiver

Multiplexing

Time-division multiplex transmitter and receiver analysis
Frequency-division multiplexing principles
Frequency-division multiplex transmitter and receiver analysis

Microwave Measurements

Attenuation measurements
Power measurements
Reflectometer measurements
Frequency measurements
Phase-shift measurements
Measurement of Q
Noise measurements
Dielectric measurements
Impedance measurements
Directional couplers
Absorption wavemeter
VSWR measurements
Coaxial-cable measurements
Propagation patterns

Radar System Principles

Block diagram analysis
CRT types
Radar sweep chains
Range-mark generator chains
Delay devices in radar systems
Radar modulators
Magnetrons

Navigational Electronics

Sonar
Loop antennas
Radio direction finders
Loran

OTHER APPLICATIONS OF ELECTRONIC DEVICES

Generators and Motors (Types and Theory)

None

Synchros and Control Systems

None

Servo Control Devices and Systems

None

Industrial Electronic Applications and Devices

Time-delay relays
High frequency wavelengths

Significant differences in future importance estimated by schools and industries.--The third hypothesis, that there would be no significant difference in the future importance estimated for each unit by school and industrial raters, was rejected for eighteen units. The format of the contingency table generated to test this hypothesis for each unit is shown below.

Variable 2: Importance

Variable 1: Source	More Important	About the Same	Less Important	Totals
Schools (group 1)				
Industries (groups 2, 3, & 4)				
Totals				

A 2 X 3 contingency table such as this one has two degrees of freedom.[7] At the .05 level of confidence with two degrees of freedom, values of chi-square greater than 5.99 are sufficient for rejection of a hypothesis.[8]

Units for which spokesmen from schools and industries estimated significantly different degrees of future importance are listed below. The list follows the arrangement used previously.

Significant Units: #3

DIRECT CURRENT

Basic Principles

None

Network Laws (A-C and/or D-C)

The superposition theorem

ALTERNATING CURRENT

Basic Principles

None

Vectors and Phase Relationships

None

Transformers

None

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[7]Ferguson, Statistical Analysis, p. 168.

[8]Ibid., p. 309.

TEST EQUIPMENT

Meter and Generator Usage

Storage oscilloscopes
Thermocouple meter
Color bar generator
Stroboscope

INDUCTANCE AND CAPACITANCE

Inductance

Instantaneous current analysis

Capacitance

Effects in D-C circuits

R-L-C Circuits

None

Parallel, Series Resonant Circuits

None

VACUUM TUBES

Fundamentals

None

Diodes

None

Triodes

None

Tetrodes

None

Pentrodes

None

Multigrid Tubes

None

Special Application Tubes

None

SEMICONDUCTORS

Fundamentals

Classification

Semiconductor Diodes

None

TRANSISTORS

Construction and Characteristics

None

Special Purpose Transistors

None

BASIC CIRCUITS AND SYSTEMS

Power Supplies

None

Amplifier Fundamentals

None

Basic Vacuum Tube Amplifiers and Circuits

None

Loudspeakers

Electrostatic speakers

Microphones and Pickups

None

Oscillators

None

R-F Amplifiers and Circuits

Single and double tuned circuits

Transmitter Fundamentals

None

Radio Transmitters and Circuits

None

Transmission of Radio Waves

Antenna fundamentals

Radio Receiver Fundamentals

None

Radio Receivers and Circuits

None

TRANSISTOR CIRCUITS

Transistor Amplifier Fundamentals

Volume and tone controls

Transistor Amplifiers and Circuits

None

Transistor Receivers

None

ADVANCED CIRCUITS AND SYSTEMS

Nonsinusoidal Waveshapes

None

Pulse and Switching Circuits

None

Digital Computer Fundamentals

None

Limiters, Clampers, Counters

None

Sweep-Generator Circuits

None

TV Transmitters and Receivers

None

MICROWAVE ELECTRONICS

Microwave Transmission

None

Special Amplifiers

Traveling-wave amplifiers
Parametric amplifiers
Lasers

Miscellaneous (Microwave)

None

Microwave Receivers

None

Multiplexing

None

Microwave Measurements

Propagation patterns

Radar System Principles

None

Navigational Electronics

None

OTHER APPLICATIONS OF ELECTRONIC DEVICES

Generators and Motors (Types and Theory)

None

Synchros and Control Systems

None

Servo Control Devices and Systems

None

Industrial Electronic Applications and Devices

Decision or intelligence devices
Simple electronic circuits

Tabulation of responses.--The objective of this study was to provide information on which to base plans for the development of electronic technology programs. Obviously, data concerning the electronic technology curriculum would be of vital importance to those responsible for this planning. The tests of the three hypotheses established certain areas wherein controversy or lack of agreement existed in regard to the curriculum. It was desirable to supplement this data with a description of the type and extent of controversy for the benefit of curriculum planners. This was accomplished by means of a table summarizing the total number of times each of the four degrees of teaching emphasis was indicated for each instructional unit by spokesmen from each industry (Table 11, Appendix S). Percentages represented by these totals are also included in the table.

Employment and Training Information

The final page of the Information Form, entitled "General Information," provided data relative to two general topics: (1) the employment situation concerning electronic technicians in Texas, and (2) general attitudes of employers toward training requirements. As with other data collected during this study, this information was summarized in a form which allowed comparisons between the participating industrial groups.

Data concerning employment.--Three questions were asked to gain information about the present number of technicians employed and the employment potential for technicians in the near future. They were:

1. If well-trained people were available, how many electronic technicians would you employ?

2. How many do you now employ?

3. How many additional technicians do you feel you will need per year for the next five years?

Responses to these questions were made by writing a number in a blank following each question. These numbers were totaled over the industrial groups. The totals are presented in Table 12.

TABLE 12

TOTAL NUMBERS OF TECHNICIANS EMPLOYED AND EMPLOYERS' ESTIMATES OF ADDITIONAL TECHNICIANS NEEDED PER YEAR FOR THE NEXT FIVE YEARS[a]

Industrial Group	Would Employ if Well-Trained People Were Available	Now Employ	Needed Per Year for Next Five Years
Research or Testing Labs	1,435	3,485	1,557
Telephone Companies	73	183	40
Commercial Broadcasters	269	412	80
Manufacturers	63	91	55
Totals	1,840	4,171	1,732

[a]Some employers reported future needs in terms of fractional equivalents, such as 2.5 technicians needed per year for five years. These fractions were included in the tabulation, but the totals in this table have been rounded to the nearest whole number.

Examination of Table 12 reveals a considerable shortage of electronic technicians in the industries surveyed. The total number of technicians who could be employed now, 1840, is approximately 44 per cent of the number now employed.

The broadcast industry shows a large proportional shortage. The reported shortage, 269, represents more than 65 per cent of the total number of technicians now employed. This proportion, although apparently exceedingly large, was substantiated by evidence from several other sources. The National Association of Broadcasters completed a survey of personnel problems within the industry during the summer of 1967. "Of the 108 responding stations, 65 or 60.2%, indicated current staff vacancies."[9] The job classification with the greatest reported number of vacancies was "technicians."[10] In addition, unsolicited letters mentioning the industry's manpower shortage were received from several broadcasters during the course of this investigation.

The manpower shortage within the broadcast industry was frequently defined in terms of training requirements. Most of these vacancies required a person with sufficient electronics training to obtain a First Class Radio

[9]Memo from Hamilton Shea, Chairman, NAB Secondary Market Television Committee, to William Walker, President, NAB, July 7, 1967. A copy of this memo was made available by Mr. Walker.

[10]_Ibid_.

Telephone Operator's license from the Federal Communications Commission.

Additional data to support reported technician shortages was not obtained for the three remaining industries. However, no reason was found to suspect any of the information obtained from these industries.

For each of the industries in Table 12, personnel needs for the next five years appear to be substantial. The estimated total yearly need for technicians is comparable to the number of technicians who could be employed now if they were available.

Sources of training for presently employed technicians.--Employers were also asked how many of the electronic technicians they presently employed received their training in (1) Texas public junior colleges, (2) Armed Forces schools, (3) college or university extension programs, (4) correspondence schools, (5) private technical schools, and (6) other sources. The numbers of technicians trained through each of these sources were summed for each industrial group. The totals appear in Table 13.

Table 13 demonstrates that the Texas public junior colleges have not contributed a very large proportion of the electronic technicians currently employed in Texas. Of the 4,365 technicians reported in this table, 9.6 per

TABLE 13

TOTAL NUMBERS OF TECHNICIANS TRAINED THROUGH VARIOUS SOURCES

Industrial Group	Texas Public Junior Colleges	Armed Forces Schools	Extension Programs	Correspondence Schools	Private Technical Schools	Miscellaneous Sources[a]	Unspecified Sources[b]
Research or Testing Labs	366	1,627	303	478	633	150	39
Telephone Companies	1	20	4	24	16	105	38
Commercial Broadcasters	41	78	48	73	187	28	9
Manufacturers	9	50	9	7	14	6	2
Totals[c]	417 (9.6%)	1,775 (40.7%)	364 (8.3%)	582 (13.3%)	850 (19.5%)	289 (6.6%)	88 (2.0%)

[a]Among the "miscellaneous" sources listed were: manufacturers' schools, on-the-job training, state universities, and "ticket mills."

[b]This category was necessary because some employers did not report training sources, but did report the number of technicians employed.

[c]The sum obtained by adding these totals (4,365) is greater than the total number of technicians reported to be employed in Table 12 (4,171). This is due to the fact that some technicians received training from more than one source.

cent received their training in junior colleges. The Armed Forces contributed 40.7 per cent, and private technical schools contributed 19.5 per cent.

It should be noted that an increase can be expected in the number of technicians trained by junior colleges. Two new junior college programs to train electronic technicians were established this year. In addition, increasing enrollments were reported by the schools visited during this study.

Attitudes toward junior college-trained technicians.--Incorporated into the "General Information" section of the Information Form was a checklist in which employers could indicate their attitudes toward six general areas of ability of junior college-trained technicians they employed. Table 14 summarizes the information received in response to this checklist. The numbers in the table represent the number of times the rating was given. Percentages are also indicated.

The table reveals that "electronic theory" and "hand skills" were rated "inadequate" most frequently by all three industrial groups. Similarly, these two abilities were rated "completely adequate" least frequently. Generally, verbal skills were considered adequate by employers, except that "writing" was rated "inadequate" more often than "speaking" and "reading." "Math related

TABLE 14

SUMMARY OF EMPLOYERS' ATTITUDES TOWARD SIX GENERAL ABILITIES OF JUNIOR COLLEGE-TRAINED ELECTRONIC TECHNICIANS

Abilities	Employers' Attitudes								
	"Completely Adequate for Our Needs"			"Fulfills Our Needs in Most Respects"			"Inadequate for Our Needs"		
	Group 2[a]	Group 3	Group 4	Group 2	Group 3	Group 4	Group 2	Group 3	Group 4
Speaking	(30.2%) 19	(30.1%) 22	(40.0%) 4	(61.9%) 39	(57.6%) 42	(60.0%) 6	(7.9%) 5	(12.3%) 9	(0.0%) 0
Reading	(34.4%) 22	(29.5%) 21	(30.0%) 3	(56.3%) 36	(55.0%) 39	(70.0%) 7	(9.4%) 6	(15.5%) 11	(0.0%) 0
Writing	(33.4%) 21	(31.0%) 22	(18.2%) 2	(50.8%) 32	(52.1%) 37	(63.6%) 7	(15.9%) 10	(16.9%) 12	(18.2%) 2
Math Related to Electronics	(19.0%) 12	(22.2%) 15	(25.0%) 3	(68.3%) 43	(59.9%) 40	(66.7%) 8	(12.7%) 8	(17.9%) 12	(8.3%) 1
Electronic Theory	(15.9%) 10	(19.4%) 14	(18.2%) 2	(57.1%) 36	(50.0%) 36	(72.7%) 8	(27.0%) 17	(30.6%) 22	(9.1%) 1
Hand Skills	(11.6%) 7	(17.8%) 13	(18.2%) 2	(45.0%) 27	(47.9%) 35	(45.5%) 5	(43.4%) 26	(34.3%) 25	(36.4%) 4

[a]Information in this table is summarized according to the industries as they were grouped for this study. Research and testing labs were placed in group 2, the communications industry in group 3, and manufacturers in group 4.

to electronics" was rated "completely adequate" less often than verbal skills, but it was rated "inadequate" less frequently than "electronic theory" and "hand skills."

<u>Data from the "Remarks" section of the Information Form</u>.--Little data was received from the "Remarks" section. Only two comments were received more than once. Eight questionnaires were returned with various comments on the need for more emphasis on practical applications of subject matter. Four of these came from research or testing labs and four came from commercial broadcasters. Two respondents from laboratories mentioned that greater emphasis should be placed on digital circuitry.

CHAPTER V

SUMMARY, CONCLUSIONS, RECOMMENDATIONS, AND IMPLICATIONS FOR PROGRAM PLANNING

This chapter is intended to provide the reader with a brief summary of the research. Conclusions and recommendations based on analysis of the data will be presented. Features and characteristics which, in the investigator's opinion, are important to any future use of the data will be presented as implications for planning.

Summary

The purpose of this study was to investigate certain aspects concerning electronic technology programs conducted in public post-secondary schools in Texas. The study was a funded project of the Texas Education Agency, and the types of data collected were those which would aid the Agency in planning the development of these programs.

Data were collected concerning (1) emphasis which should be given to various units in the electronic technology curriculum, (2) estimates of future importance of these units, (3) numbers of electronic technicians presently employed in Texas and sources from which they received their training, (4) projections of additional technicians needed for the next five years, and (5) attitudes of employers toward certain abilities of technicians who were trained in Texas junior colleges. Information was compiled to provide an overview of facilities and equipment presently available for use by electronic technology programs. School officials provided information about attitudes toward and opportunities for professional development of staff members.

The degree of teaching emphasis preferred and the estimates of future importance for the various units were compared between (1) the different industries surveyed and (2) schools and industries. Chi-square was the technique employed to test these comparisons for significant differences. Data on the remaining topics were tabulated for purposes of analysis and comparison.

Conclusions

On the basis of the information gained from this project, the following conclusions were drawn:

1. Representatives of the industries participating in this study were not in agreement concerning the degree of teaching emphasis which should be given certain units.

2. Teachers and industrial raters participating in this research were not in agreement concerning the degree of teaching emphasis which should be given certain units.

3. Teachers and industrial raters were not in agreement concerning estimates of the future importance of certain units.

4. Physical facilities at the training institutions which participated in this study were adequate, and at some schools they were outstanding. New buildings which are in planning or construction stages will contribute toward maintaining the present level of adequacy during the immediate future.

5. There is a considerable difference among Texas public junior colleges in the adequacy of laboratory and/or test equipment. The lack of equipment is a definite hindrance to the quality of the electronic technology programs at certain schools.

6. There was no serious lack of hand tools at any of the cooperating schools. However, most schools needed some items.

7. Cooperating teachers and cooperating industrial spokesmen were generally agreed as to which items of electronic equipment were most important for a technician to be able to operate well.

8. Personnel in charge of electronic technology instruction at the cooperating colleges were aware of desirable changes in the curriculum. These changes are

being implemented within the limitations placed by the present lack of certain equipment.

9. Few opportunities for professional development are available to teachers in junior college electronic technology programs in Texas.

10. The teachers at the colleges which were listed had a wide range of industrial experience. They were not in agreement as to the minimum amount of industrial experience which should be required for a teacher in an electronic technology program.

11. The majority of the teachers interviewed were employed on a nine-month basis.

12. The teachers were generally not in favor of a week-end in-service training program. They suggested that a program whereby teachers could work in industry during summers would be more satisfactory.

13. The curriculum section of the Information Form was longer and more detailed than would have been required to determine an indication of necessary curriculum changes.

In the execution of the various procedures followed in gathering data related to the specific objectives of this project, various "incidental" information was accumulated. Some of these facts were reported voluntarily during interviews or letters. Others became apparent in other ways, such as an apparent discrepancy in the meaning assigned to a certain term by various groups. Conclusions with considerable significance for electronic technology in Texas can be formed from this information. The conclusions follow, with substantiating statements.

Need for counseling.--Many students who complete high school in Texas are not aware of the opportunities open to them through technical education. During interviews, school representatives frequently made reference to one or more of the following conditions:

1. There is a serious shortage of counselors in junior and senior high schools.

2. Counselors often are not aware of the opportunities in technical education.

3. Many counselors apparently do not know what prerequisites are necessary for the successful completion of a technical program.

4. Most parents of junior and senior high school students are not aware of the opportunities in technical education and, in fact, often advise their children to avoid technical education in favor of four-year baccalaureate degree curriculums.

5. A considerable proportion of the best students currently enrolled in technical programs are drop-outs from other curriculums.

The school representatives with whom this topic was discussed were of the opinion that correction of these situations should begin immediately, through implementation of a program to disseminate information directly to students, parents, and counselors. Further, they believed that a great many of the counselors currently employed in the public schools should be re-trained concerning technical education.

Understanding of terminology.--The term "electronic technician" is often confused with other terms and in fact may be generally misunderstood by many people not directly involved with technical education. No evidence of this misunderstanding was evident from contacts with school personnel. However, an incident which occurred repeatedly suggests the possibility insofar as the general public is concerned.

During the preliminary survey, the president of each company contacted was asked to indicate if the company employed electronic technicians. Questionnaires were then sent to all companies indicating that they did employ technicians and that they would participate in the study. In several (approximately ten) cases, the questionnaire was returned by a company spokesman without having been completed, accompanied by a statement to the effect that the company did not employ anyone with the training indicated in the Information Form. This suggests that the person who responded during the preliminary survey did not associate the term "electronic technician" with the training involved. If he had, he would assumedly have declined to participate during the preliminary survey.

Recommendations

On the basis of the information accumulated during this project, the following recommendations are made:

1. The Texas Education Agency should provide for closer coordination of all aspects of electronic technician training programs, the following in particular: (1) coordination of the programs with industry, (2) coordination between the school programs, and (3) coordination between the Agency and each individual program.

2. A review of policies governing pay increments for teachers in electronic technology programs should be conducted. This review should include an investigation into the possibility of establishing a dual salary schedule system. Under such a dual system, the present schedule would be supplemented by including provisions for additional pay increments based upon recent industrial experience. Consideration should also be given to establishment of a policy whereby teachers who work in industry during summer months could be reimbursed actual

costs of moving and other expenses directly related to establishing residence within reasonable distance of the summer employment. In considering both of these suggestions, a primary requirement should be that the industrial experience in question would enhance the individual teacher's capability to perform his teaching duties after the experience was completed. Further, the teacher should be required to continue to teach in a technical program in Texas for at least one year or suffer the loss of the pay increment and/or the reimbursement of expenses.

3. The Texas Education Agency should support all efforts to make information about electronic technology available to junior and senior high school students and their parents, and to junior and senior high school counselors. In view of the present shortage of vocational counselors in the public schools, the possibility of establishing a special program to disseminate this kind of information should be considered.

4. The degree to which counselors understand the implications for counseling students into technical programs should be established as soon as possible.

5. Research to gather information about the aspects of technical education investigated during this study should be repeated periodically. Special consideration

should be given to proposals which include the gathering of information through personal interviews and photographs.

6. Plans for further use of the curriculum section of the Information Form should include consideration of selecting a smaller sample of the instructional units.

Implications for Program Planning

Throughout this report, an attempt has been made to summarize data in a form which would be most usable for planning. The conclusions and recommendations were stated as simply and directly as possible, in an attempt to avoid misunderstanding or misinterpretation. The purpose of this was to make implications related to this project seem obvious.

The information gained through this research was factual, and as such can be defended. Related to these facts are certain characteristics of the general situation concerning electronic technology education in Texas, and it is in relation to these characteristics that implications become important. Probably only a few of these characteristics were encountered during this research, and many of those encountered surely went unrecognized. Awareness of this prompts caution in identifying "implications" which are not defensible as pure fact. However, certain features and characteristics encountered during the project should be mentioned in concluding this report.

One of these is that the investigator enjoyed a unique position during the course of this project. First, he was not directly associated with the Texas Education Agency or any of the schools and industrial concerns which furnished data. Second, all the people with whom the project was discussed were strangers at the time the project was begun. With no prior knowledge, the investigator possibly enjoyed the advantage of being able to assess situations and facts more objectively than someone who has been involved with technical education in Texas for some time. However, to maintain objectivity, it is important to remember that there are also many disadvantages in entering strange situations. One of these is the inability to detect misrepresentations if they should occur.

The purpose of elaborating on the investigator's relationship to other principals involved in the study, however, is to point out that a positive attitude toward improvement of programs was evident at all levels. Officials in the Texas Education Agency showed concern for obtaining information which would enable them to assess the present situation and develop plans for strengthening electronic technology programs throughout the state.

Representatives of the colleges were interested in providing the best training possible, based on the preferences and needs of the industries which hire the graduating technicians.

The obvious implication is that a good framework exists in which to use the data supplied by this study. It appears that the relative amount of progress which is ultimately achieved will depend largely on the attitude carried into the effort by the principals involved.

A further implication pertains to willingness to cooperate in this effort. As has been described, information was obtained from the colleges through interviews with representatives of the various electronic technology departments. These representatives supplied information openly and willingly. This leads to the implication that the greatest amount of interest in maintaining high quality programs of instruction is probably at the classroom level, and that teachers should be as closely involved in planning as possible. Directly associated with this implication is the fact that the teachers probably have the greatest knowledge of electronics. They should therefore be well qualified to render judgements concerning possible developments. Further, all teachers interviewed during this research maintained close contacts with industry. Persons with such up-to-date industrial contacts could make valuable contributions to program planning.

To imply that teachers might be more closely involved in planning is not the same as to imply that they should do the planning alone. Neither is it the same as implying that present plans are poorly founded or that those who now do the planning are poorly chosen. The implication should be interpreted as an effort to point out a potential for a great increase in effectiveness.

Finally, involvement of personnel at the classroom level would seem to be the most direct method of utilizing information from this project within the framework previously mentioned. In the opinion of the investigator, all those involved in the effort to train electronic technicians have at least one thing in common--the desire to train good technicians. The implications for close coordination of the efforts of all these individuals are obvious.

With regard to the employment situation for electronic technicians, a quite obvious implication is that immediate provisions should be made for increasing the number of technicians trained. On the basis of employer's reports, a substantial number of technicians could be employed immediately. It also appears that there will continue to be demand for technicians during the next five years. If substantially larger numbers of students can be attracted into present training programs, it will be necessary to review the adequacy of staff personnel, equipment, and physical facilities at each school.

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APPENDICES

APPENDIX A

LETTER TO COMPANY PRESIDENTS

Electronic Technology Study — State of Texas, 1968 - 1969

Cooperating Agencies:
Texas Education Agency
Texas Engineering Experiment Station
Industrial Education Department, Texas A&M

Address Correspondence to:
Jerauld B. Wright
Drawer BD
College Station, Texas 77840

I am beginning a study to determine certain facts about the training of electronic technicians in Texas. The research will be conducted through the facilities of the Engineering Experiment Station at Texas A&M, and underwritten by the Department of Vocational and Adult Education of the Texas Education Agency. As a preliminary step in this project, I am trying to determine how many non-degree electronic technicians are employed by manufacturers of electrical and electronic components and equipment in the state. I would like to enlist the cooperation of all companies which employ significant numbers of these workers.

Cooperation in the research will involve an estimated one to two hours' time on the part of one of your project directors or supervisors who is aware of the training needs of the electronic technicians you employ. His responsibility would be to complete a questionnaire which I will mail to him. The questionnaire will be designed to obtain your company's opinions concerning the instructional emphasis which should be given the various units in the curriculums of training programs. I will provide a stamped envelope addressed to myself for returning the questionnaire. All data will be handled and presented in such a way as to insure that all individuals and companies who participate may remain anonymous. In return for your cooperation in the study, I will inform you of the results if you desire.

On the enclosed reply card, please fill in the <u>name</u> and <u>complete mailing address</u> of one person in your company who will be my "contact" individual for this research. I will write him soon. If you do not feel that you can participate in this research, please check the appropriate square on the card. I will appreciate your returning the card whether you participate or not.

Thank you for your consideration. I hope you can find time in your busy schedule to help me achieve an educational goal, at the same time promoting the interest of technical education in Texas.

Sincerely,

Jerauld B. Wright
Principal Investigator

Approved:

James L. Boone, Jr.
Associate Professor
Project Director

APPENDIX B

INDUSTRIAL REPLY CARD

Address Side of Card:

Jerauld B. Wright

Drawer BD

College Station, Texas 77840

Message Side of Card:

We employ _____ non-degree electronic technicians.

▱ We will cooperate in the electronic technology study. Your "contact" individual for this research will be:

(Name) ______________________________

(Title or Position) ______________________________

(Address) ______________________________

____

▱ We cannot cooperate in this study.

Remarks: ______________________________

APPENDIX C

LETTER TO COMPANY SPOKESMEN

Electronic Technology Study — State of Texas, 1968 - 1969

Cooperating Agencies:
Texas Education Agency
Texas Engineering Experiment Station
Industrial Education Department, Texas A&M

Address Correspondence to:
Jerauld B. Wright
Drawer BD
College Station, Texas 77840

Recently I wrote the president of your company, asking for cooperation in the Electronic Technology Study. At that time I requested that he name someone whom I might contact for the information I will need from your company. He suggested that you were the person best qualified to be your firm's spokesman during this project.

The purpose of the Electronic Technology Study is to provide the Texas Education Agency with current information concerning post-secondary electronic technician training programs in Texas. Spokesmen for companies in Texas which employ electronic technicians will be asked to rate each unit in the curriculum according to the degree of teaching emphasis required. From these ratings, school administrators will be able to direct the efforts of their programs toward the needs of employers.

An attempt will also be made to provide information which will help school administrators plan effectively for the future. This information will be derived from estimates made by industrial spokesmen concerning the training needs of future technicians and the number of these workers needed in the foreseeable future.

The data for the study will be gathered by means of a checklist which will be sent to each company spokesman. You can expect to receive this checklist, along with a stamped envelope for returning it to me, in about three or four weeks.

I am looking forward to working with you on this project--response to the study so far has been excellent.

Sincerely,

Jerauld B. Wright
Principal Investigator

APPENDIX D

FOLLOW-UP LETTER USED DURING PRELIMINARY SURVEY OF INDUSTRY

Electronic Technology Study — State of Texas, 1968 - 1969

Cooperating Agencies:
Texas Education Agency
Texas Engineering Experiment Station
Industrial Education Department, Texas A&M

Address Correspondence to:
Jerauld B. Wright
Drawer BD
College Station, Texas 77840

In the middle of January I attempted to contact you in reference to an electronic technology study for the Texas Education Agency. Inasmuch as I have not heard from you, I am considering the possibility that you did not receive the letter.

I am enclosing a copy of the original letter, along with another reply card. I will appreciate your filling in the information requested on this card and dropping it in the mail, so that I may have complete information for this phase of the study. Please return this reply card even if you returned the first one, because there is also the possibility that it was delayed or lost in the mail.

Thank you for your cooperation.

Sincerely,

Jerauld B. Wright
Principal Investigator

APPENDIX E

LETTER TO COLLEGE PRESIDENTS

Electronic Technology Study — State of Texas, 1968 - 1969

Cooperating Agencies:
Texas Education Agency
Texas Engineering Experiment Station
Industrial Education Department, Texas A&M

Address Correspondence to:
Jerauld B. Wright
Drawer BD
College Station, Texas 77840

I am beginning a doctoral study to gather information about electronic technology programs in post-secondary schools in Texas. I would like to enlist the cooperation of ______ College in this research.

A primary purpose of this study is to gather information from employers of electronic technicians concerning the degree of teaching emphasis they believe is necessary for each unit in the curriculums of training programs. Employers will also be asked to give their estimates of the way educational needs of electronic technicians will change in the next few years, to provide a better basis for planning the development of these programs. School program spokesmen will be asked for the same information, and comparisons between school and industrial responses will be made.

The study is being conducted through the facilities of the Engineering Experiment Station at Texas A&M, and supervised by the staff of the Industrial Education Department. The study is sponsored by the office of Post Secondary Vocational Program Development, Texas Education Agency.

Your school's cooperation in the research will involve only one member of your electronic technology staff. His responsibility will be to complete a questionnaire which I will send him and to hold a short interview with me at your school at some time convenient to both of us. During the interview I would like to have him point out distinctive or unique features of your facilities so that I may photograph them. Also during the interview, I will pick up the questionnaire he will have completed. No more than three hours of his time should be involved altogether. In return for your cooperation, I will furnish a detailed report of the outcome of the study. All data will be handled and presented in such a manner that all participants will remain anonymous.

Please check the appropriate square on the reply card I have enclosed, indicating whether you can cooperate or not. Also please fill in the name and complete mailing address of the person you would like to represent your school during this project.

Thank you for your cooperation. I will appreciate your school's cooperation in this research, and I hope to hear from you soon.

Sincerely,

Jerauld B. Wright
Principal Investigator

Approved:

James L. Boone, Jr.
Associate Professor
Project Director

APPENDIX F

COLLEGE REPLY CARD

Address Side of Card:

Jerauld B. Wright

Drawer BD

College Station, Texas 77840

Message Side of Card:

☐ We will cooperate in the electronic technology study. Your "contact" individual for this research will be:

(Name) ____________________

(Title or Position) ____________________

(Address) ____________________

____

☐ We cannot cooperate in this study.

Remarks: ____________________

APPENDIX G

LETTER TO COLLEGE SPOKESMEN

Electronic Technology Study — State of Texas, 1968 - 1969

Cooperating Agencies:
Texas Education Agency[1]
Texas Engineering Experiment Station
Industrial Education Department, Texas A&M

Address Correspondence to:
Jerauld B. Wright
Drawer BD
College Station, Texas 77840

Some time ago I wrote the president of __________ College to inquire if the college would like to participate in the Electronic Technology Study. I also requested that he name someone for me to contact for the information I will be seeking from your school. He suggested that you were the person best qualified to do this, so I am writing you to explain what your participation will involve.

The purpose of this study is to gather current information for the Texas Education Agency about the training of electronic technicians in Texas. Information about the emphasis given various units in the curriculum and information about facilities and equipment will be gathered from institutions which offer such technical programs. Similarly, industries which employ (or are potential employers of) large numbers of electronic technicians will be asked to supply information about the training needs of technicians they employ. Data obtained from these sources will be compared in order to identify areas in which present training is fulfilling needs and to develop plans for providing improvement where necessary.

I would like to arrange a time before the end of March when I can visit you at your school. I will want to take pictures of your facilities, and talk with you about plans for developing your program in the next few years. I would like to arrange this visit to enable me to visit other schools in your general area on the same trip, so I must determine when it would be possible for people at the various schools to see me. As a means of obtaining this information, I am sending you calendar blanks for February and March. Please cross out days when you cannot see me and mail the calendar blanks back to me in the enclosed envelope. When I have received this information from everyone concerned, I will contact you again to set up a definite date. I would like to schedule my visit to ______ during the last week in February if possible.

Several days before our scheduled interview, I will send you a checklist concerning the curriculum. I will plan to pick it up from you during the interview. It will probably take you about a half hour to complete this form.

During the interview, I would also like to obtain floor plans of your electronic technology classrooms and laboratories, if this is possible. Almost any scale will do if basic dimensions are furnished.

I am looking forward to meeting you and working with you on this project.

Sincerely,

Jerauld B. Wright
Principal Investigator

APPENDIX H

INFORMATION FORM

INFORMATION FORM

Electronic Technology Study

CONDUCTED FOR THE TEXAS EDUCATION AGENCY

1968-69

How to fill out this form:

Please read these directions carefully, to help you provide proper responses in the multiple columns. The white columns are for you to indicate the degree of teaching emphasis you think each item should be given at the present time. The red columns are for you to indicate how important you think each item will be five years from now, basing your estimate on how important it is now.

WHITE COLUMNS:

After each instructional item, please check (✓) one of the four white columns to indicate the degree of teaching emphasis you think the item should be given. Choose one of the four columns according to the definitions in the table below.

DEGREE OF EMPHASIS	Definitions of headings on white columns in terms of:			
	Teacher Effort	Objectives	Lab Time	Student Responsibility
TAUGHT IN DEPTH	Complete, detailed instruction, including all related information.	Student will develop a complete understanding, including ability to apply the knowledge in practical situations.	One or more lab sessions related to the topic.	Student realizes this is very important material.
EMPHASIZED	Class discussion devoted specifically to this topic.	Student will develop a general knowledge, although not necessarily a high degree of skill in applying the knowledge in any situation.	Topic included in laboratory practice.	Student realizes this is important material.
DISCUSSED BRIEFLY	Mentioned or discussed briefly in one or two class sessions.	Student will develop a familiarity with terms and general ideas concerning the topic.	Topic may be encountered while doing lab work.	Student realizes this material is not too important.
NOT TAUGHT	May be mentioned incidentally or possibly not at all.	Topic is not included in the objectives for the course.	No lab practice.	Student realizes this material is not important.

IF YOU DON'T AGREE EXACTLY WITH ANY OF THE DEFINITIONS, CHOOSE THE ONE THAT MOST CLOSELY AGREES WITH YOUR OWN DEFINITION.

RED COLUMNS:

After each item, also check (✓) one of the three red columns to indicate your opinion of whether the item will be more important after five years than it is now, about the same importance after five years as it is now, or less important after five years than it is now.

INFORMATION FORM
BASIC ELECTRONIC KNOWLEDGE REQUIREMENTS OF ELECTRONIC TECHNICIANS

INSTRUCTIONAL UNITS OR ITEMS — Card 01	Taught in Depth	Emphasized	Discussed Briefly	Not Taught
DIRECT CURRENT				
Basic Principles				
electrical resistance, voltage, and current				
prefixes (mili-, micro-, etc.)				
powers of 10				
batteries				
magnetic fundamentals				
series, parallel, and combination circuit theory				
D-C circuit applications				
troubleshooting D-C circuits				
Network Laws (A-C and/or D-C)				
Ohm's law				
Kirchhoff's laws				
power formulas				
Thevenin's theorem				
Norton's theorem				
Millman's theorem				
the superposition theorem				
maximum power transfer theorem				
ALTERNATING CURRENT				
Basic Principles				
electromagnetism				
wave shapes				
electromotive force				
Vectors and Phase Relationships				
vectors and vector diagrams				
instantaneous values				
phase relationships				
complex numbers (J operator)				
polar coordinates				
Transformers				
theory				
turns ratio				
impedance matching				
transformer losses and ratios				
types and applications (general)				
three-phase (delta and wye connections)				
frequency response				
TEST EQUIPMENT				
Meter and Generator Usage				
basic meter movements				
VTVM's				

INSTRUCTIONAL UNITS OR ITEMS — Card 02	Taught in Depth	Emphasized	Discussed Briefly	Not Taught
transistor voltmeters				
multimeters				
ohmmeters				
storage oscilloscopes				
laboratory oscilloscopes				
wavemeters				
impedence bridge				
A-C bridge				
thermocouple meter				
wattmeter				
tube testers				
transistor analyzers				
transistor curve tracers				
X-Y plotters				
capacitor testers				
Q meter				
frequency meter				
sine-wave generators				
signal generators (a-f and r-f)				
pulse generator				
square wave generator				
sweep generator				
linearity generator				
time mark generator				
time domain reflectometer				
color bar generator				
stroboscope				
digital counters				
digital voltmeters				
nuclear instruments				
INDUCTANCE AND CAPACITANCE				
Inductance				
self-inductance				
mutual inductance				
series and parallel				
Lenz's law				
inductive reactance				
instantaneous current analysis				
a-f and r-f chokes				
Q of a coil				
Capacitance				
theory of operation				
capacitor types and rating				
effects in D-C circuits				
R-C circuits and time constants				
capacitive reactance				
bypass capacitor effect				
R-L-C Circuits				
series R-L-C circuits				
parallel R-L-C circuits				

Card 03

INSTRUCTIONAL UNITS OR ITEMS	Taught in Depth	Emphasized	Discussed Briefly	Not Taught
phase relationships and effects of varying circuit properties				
Parallel, Series Resonant Circuits				
resonant circuit "Q"				
analysis of series and parallel resonant circuits				
resonant circuit bandwidth				
applications of resonant circuits				
frequency response curves				
resonant filters				
VACUUM TUBES				
Fundamentals				
early development and use				
emitter materials				
types of envelopes and bases				
types of emission				
cathodes; directly and indirectly heated				
Diodes				
characteristic curves				
rectification, detection				
Triodes				
biasing methods, positive and negative				
load lines				
saturation				
interelectrode capacitance				
transconductance, plate resistance, amplification factor				
static and dynamic characteristic curves				
transfer curves				
voltage amplification				
equivalent circuits				
Tetrodes				
interelectrode capacitance				
effect of screen grid				
effects of secondary emission				
plate and screen characteristic curves				
Pentodes				
effects of suppressor grid				
plate and dynamic characteristic curves				
tube parameters				
sharp and remote cutoff characteristics				
beam power tubes				
Multigrid Tubes				
pentagrid converters				
pentagrid mixers				
Special Application Tubes				
multisection tubes				
subminiature tubes				
gas-filled regulators				

Card 04

INSTRUCTIONAL UNITS OR ITEMS	Taught in Depth	Emphasized	Discussed Briefly	Not Taught
thyratron tubes				
ignitrons				
phototubes				
photo-multiplier tubes				
electron-ray indicators				
cathode-ray tubes				
high frequency tubes				
klystrons				
SEMICONDUCTORS				
Fundamentals				
early development and usage				
atomic structure				
crystal structure				
bonds				
impurities				
classification				
electrons and hole charges				
Semiconductor Diodes				
color code				
PN junctions				
forward and reverse bias				
characteristic curves				
types of diodes (point-contact, tunnel, zener, photo, etc.)				
silicon controlled rectifiers and switches				
variable-capacitance diodes				
hall generators				
TRANSISTORS				
Construction and Characteristics				
transistor fabrication				
configurations				
current gain				
junction type transistors				
static characteristic curves				
dynamic transfer curves				
transistor biasing				
physical circuit operation (NPN and PNP)				
load lines				
graphical analysis				
thermal properties				
operating point				
transistor noise				
"r" parameter				
hybrid parameters				
Special Purpose Transistors				
tetrode transistors				
photosensitive transistors				
power transistors				
unijunction transistors				
field-effect transistors				
thyristors				
microcircuits (including integrated circuits)				

INSTRUCTIONAL UNITS OR ITEMS Card 05	Taught in Depth	Emphasized	Discussed Briefly	Not Taught
BASIC CIRCUITS AND SYSTEMS				
Power Supplies				
half and full wave rectifiers				
principles of filtering				
voltage dividers and doublers				
polyphase power supplies				
r-f power supplies				
voltage-regulator circuits				
power supply troubleshooting				
Amplifier Fundamentals				
biasing and classes of operation (A, B, C, etc.)				
decibels				
stereophonic sound				
D-C amplifier gain				
A-C amplifier gain				
magnetic amplifiers				
frequency response				
Basic Vacuum Tube Amplifiers and Circuits				
paraphase amplifiers				
cathode follower a-f amplifiers				
push-pull a-f amplifiers				
i-f amplifiers				
amplifier coupling				
audio preamplifier circuits				
audio-output stage				
tone control circuits				
bandpass amplifier circuits				
attenuators				
delayed-action circuits				
Loudspeakers				
headsets				
dynamic speakers				
electrostatic speakers				
P-M speakers				
speaker enclosures				
Microphones and Pickups				
carbon				
capacitor				
crystal				
dynamic				
velocity				
ceramic				
Oscillators				
phase-shift oscillators				
tuned plate-grid oscillators				
Hartley oscillators				
Colpitts oscillators				
Armstrong oscillators				
electron-coupled oscillators				
Pierce oscillators				
crystal overtone oscillators				
R-F Amplifiers and Circuits				
r-f amplifier circuits (general)				
r-f power amplifiers				
wide-band amplifiers				

INSTRUCTIONAL UNITS OR ITEMS Card 06	Taught in Depth	Emphasized	Discussed Briefly	Not Taught
single and double tuned circuits				
neutralizing circuits				
r-f buffer and frequency mulitpliers				
troubleshooting procedures				
Transmitter Fundamentals				
c-w transmitter keying				
classification of wave emission				
parasitics and harmonics				
power distribution in a-m wave				
transmitter measurements				
a-m, f-m comparisons				
transmitter alignment				
Radio Transmitters and Circuits				
c-w transmitters				
vhf transmitters				
uhf transmitters				
a-m transmitters and circuits				
sideband transmitters				
f-m (reactance tube) transmitters				
f-m (phase) transmitters				
troubleshooting procedures				
Transmission of Radio Waves				
principles of radiation and propagation				
antenna fundamentals				
transmission line theory				
types of antennas				
FCC regulations				
Radio Receiver Fundamentals				
reading schematic diagrams				
heterodyning principles				
a-m detection				
f-m detection				
alignment procedures				
troubleshooting procedures				
Radio Receivers and Circuits				
T-R-F receivers				
superhet receivers (general)				
am-fm receivers				
sideband receivers				
special receiver circuits				
AVC circuits				
the B+ supply				
squelch circuits				
limiters				
discriminators				
TRANSISTOR CIRCUITS				
Transistor Amplifier Fundamentals				
reading transistor specifications				
classes of operation				
current, voltage, and power gain				
base, emitter, collector phase relationships				
input and output resistance				
volume and tone controls				
effects of feedback				

INSTRUCTIONAL UNITS OR ITEMS Card 07	Taught in Depth	Emphasized	Discussed Briefly	Not Taught
equivalent circuits				
transistor measurements				
troubleshooting procedures				
Transistor Amplifiers and Circuits				
common emitter, collector, and base configurations				
push-pull amplifiers				
cascade audio amplifiers				
R-C coupled audio amplifiers				
transformer coupled amplifiers				
direct coupled amplifiers				
power amplifiers				
tuned amplifiers				
reflex amplifiers				
D-C amplifiers				
r-f and i-f amplifiers				
wide-band amplifiers				
preamplifiers				
phase inverters				
bridge arrangements				
symmetry circuits				
transistor current regulators				
transistor voltage regulators				
bias circuits				
printed circuits				
Transistor Receivers				
power supplies				
oscillators				
modulation, mixing, and detection circuits				
agc circuits				

ADVANCED CIRCUITS AND SYSTEMS

INSTRUCTIONAL UNITS OR ITEMS Card 07	Taught in Depth	Emphasized	Discussed Briefly	Not Taught
Nonsinusoidal Waveshapes				
square waves				
rectangular waves				
sawtooth waves				
triangular and peaked waves				
multi-segmented waves				
curved wave forms				
transients				
D-C components of waveforms				
A-C components of waveforms				
waveform generation				
Pulse and Switching Circuits				
diode and triode switching circuits				
free running multivibrators				
bistable multivibrators				
monostable multivibrators				
astable multivibrators				
blocking oscillators				
shock-excited oscillators				
gas-tube relaxation oscillators				
gating circuits				
delay circuits				

INSTRUCTIONAL UNITS OR ITEMS Card 08	Taught in Depth	Emphasized	Discussed Briefly	Not Taught
saturable-core reactor circuits				
pulse generators				
triggering circuits				
pulse counters				
logic circuits				
pulse amplifiers				
linear wave shaping				
binary systems				
decimal systems				
null detectors				
Digital Computer Fundamentals				
computer applications				
computer programming				
computer math				
adders and subtractors				
methods of data storage				
analog-to-digital conversion				
Limiters, Clampers, Counters				
diode limiters				
triode limiters				
diode clamping				
counters (frequency divider)				
diode clippers				
Sweep-Generator Circuits				
sawtooth-wave form circuits				
gas-tube sweep generator circuits				
vacuum-tube sweep generator circuits				
transistor sweep generator circuits				
sweep expansion and delay circuits				
TV Transmitters and Receivers				
frequency bands				
standard interlaced scanning				
composite TV picture signal				
camera tubes				
TV image and image resolution				
TV transmitter functional analysis				
TV receiver functional analysis				

MICROWAVE ELECTRONICS

INSTRUCTIONAL UNITS OR ITEMS Card 08	Taught in Depth	Emphasized	Discussed Briefly	Not Taught
Microwave Transmission				
communications transmitters				
radar transmitters				
generating microwave signals				
cavity resonators				
waveguides				
duplexers				
microwave antennas				
transmission lines				
wavelength measurement				
Special Amplifiers				
grounded-grid amplifiers				

INSTRUCTIONAL UNITS OR ITEMS Card 09	Taught in Depth	Emphasized	Discussed Briefly	Not Taught
video amplifiers				
D-C amplifiers				
traveling-wave amplifiers				
parametric amplifiers				
masers				
lasers				
Miscellaneous (microwave)				
backward-wave oscillators				
microwave mixers				
using Smith chart				
Microwave Receivers				
communications receiver				
radar receiver				
Multiplexing				
time-division multiplexing principles				
time-division multiplex transmitter and receiver analysis				
frequency-division multiplexing principles				
frequency-division multiplex transmitter and receiver analysis				
Microwave Measurements				
attenuation measurements				
power measurements				
reflectometer measurements				
frequency measurements				
phase-shift measurements				
measurement of Q				
noise measurements				
dielectric measurements				
impedance measurements				
directional couplers				
absorption wavemeter				
VSWR measurements				
coaxial-cable measurements				
propagation patterns				
Radar System Principles				
block diagram analysis				
CRT types				
radar sweep chains				
range-mark generator chains				
delay devices in radar systems				
radar modulators				
magnetrons				
Navigational Electronics				
sonar				
loop antennas				
radio direction finders				
loran				

INSTRUCTIONAL UNITS OR ITEMS Card 10	Taught in Depth	Emphasized	Discussed Briefly	Not Taught
OTHER APPLICATIONS OF ELECTRONIC DEVICES				
Generators and Motors (Types and Theory)				
A-C and D-C generators				
A-C and D-C motors				
single-phase principles				
three-phase principles				
converters, inverters, and dynamotors				
generator and motor maintenance				
speed regulators				
automatic motor controls				
Synchros and Control Systems				
synchro applications				
synchro principles				
differential synchro				
synchro control transformer				
geared synchro systems				
synchro capacitors				
synchro connections				
Servo Control Devices and Systems				
fundamental servo principles				
common servomechanism systems				
servomechanism chains				
frequency response of servo systems				
Industrial Electronic Applications and Devices				
decision or intelligence devices				
electronic control systems				
simple electronic circuits				
ultrasonics				
electronic heating and welding				
transducers				
thermistors				
temperature recorders				
varistors				
time-delay relays				
large-current polyphase rectifiers				
high frequency wavelengths				
high-speed light and register controls				
thyratron controls				
electronic timer circuits				
radiation inspection and detection				
photoelectric devices				

(PLEASE GO ON TO THE LAST PAGE).

GENERAL INFORMATION

1. Please answer these questions about the training and hiring of electronic technicians:

   a. If well-trained people were available, how many electronic technicians would you employ? . . . . (Number) . . . . . . ☐

   b. How many do you now employ? . . . . (Number) . . . . . . ☐

   c. How many additional electronic technicians do you feel you will need per year for the next five years? . . . . (Number) . . . . . . ☐

   d. How many of the electronic technicians you now employ received their training in:

      Texas Public Junior Colleges? . . . . (Number) . . . . . . ☐

      Armed Forces Schools? . . . . (Number) . . . . . . ☐

      College or University Extension Programs? . . . . . . (Number) . . . . . . ☐

      Correspondence Schools? . . . . (Number) . . . . . . ☐

      Private Technical Schools? . . . . (Number) . . . . . . ☐

      Others? (Specify) . . . . (Number) . . . . . . ☐

2. As far as your company is concerned, junior-college-trained electronic technicians are receiving training which is: (CHECK ONE SQUARE AFTER EACH ITEM) →

	Completely adequate for our needs	Fulfills our needs in most respects	Inadequate for our needs
a. Communications skills			
Speaking			
Reading			
Writing			
b. Math related to electronics			
c. Electronic theory			
d. Ability to perform hand skills and/or use test equipment in practical situations			

   e. Remarks ____

3. What three items of equipment should electronic technicians you employ be most skilled in operating?

_______________ _______________ _______________

If you would like to be informed of the results of this study, please write your name and address:

____

____

____

Please return to:

JERAULD B. WRIGHT

DRAWER BD

COLLEGE STATION, TEXAS 77840

APPENDIX I

FORM USED TO VALIDATE TERMS USED FOR COLUMN HEADINGS IN THE INFORMATION FORM

Dear Graduate Student:

In preparation for a research project, I must determine a consensus of the interpretation of certain terms by persons familiar with industrial education. Please write your interpretation of each of the four terms listed below, in two sentences or less. You may want to express your interpretation in terms of how well the student would know the material, or in terms of the amount of class time necessary to teach to that degree. Feel free to approach the definitions from any other point of view if you feel it is a better one.

Here are the terms:

Taught in Depth:

Emphasized:

Discussed Briefly:

Not Taught:

Do you feel that these terms represent four approximately equally spaced points in a continuum of possible teaching emphasis?

Yes ____________________ No __________________

If not, what other terms would you suggest?

Please return this form to carrel #15, or put it in my mailbox. Thank you for your cooperation.

APPENDIX J

HAND TOOL AND SHOP EQUIPMENT LIST

HAND TOOL AND SHOP EQUIPMENT LIST

DIRECTIONS: In the blank after each item, write the number of units of that item that is available in your laboratory. If you do not have the item, write "0" in the blank.

ITEM	NO.	ITEM	NO.
Long-nose Plier	____	Tap and Die Set	____
Utility Plier	____	Open End Wrench Set	____
Diagonal Cutter	____	Adjustable Wrench	____
Wire Stripper	____	"Vise Grip" Wrench	____
Tweezer	____	Hole Punch Set	____
Tin Snip	____	Square Hole Punch Set	____
Miniature File Set	____	Screwdrivers, Slotted, Assorted Sizes	____
Mill File, Approx. 10"	____	Offset Screwdriver	____
Square File	____	Phillips Screwdriver	____
Round File	____	Allen Hex Screwdriver Set	____
Triangular File	____	Jeweler's Screwdriver	____
Ball Peen Hammer	____	Nut Driver Set	____
Claw Hammer	____	Alignment Tool Set	____
Center Punch	____	Hand Drill	____
Prick Punch	____	Hack Saw Frame	____
Starting (Tapered) Punch	____	Propane Torch	____
Pin Punch	____	Wire Brush	____
Cold Chisel, Assorted	____	Others (Please list below)	
Combination Square	____	____________	____
Try Square	____	____________	____
Framing Square	____	____________	____
Flexible Steel Tape	____	____________	____
Steel or Wood Rule	____	____________	____
Compass	____	____________	____
Divider	____	____________	____
Soldering Gun	____	____________	____
Soldering Iron	____		
Soldering Pencil	____		
Drill Press, 1/2" Chuck	____		
Portable Electric Drill, 1/4" or 3/8"	____		
Bench Grinder	____		
Lathe, Small (1/2" stock)	____		
Bench Vise	____		

APPENDIX K

LABORATORY AND TEST EQUIPMENT LIST

LABORATORY AND TEST EQUIPMENT LIST

DIRECTIONS: In the blank after each item, write the number of units of that item (or very similar item) that is available in your laboratory. If you do not have the item, write "0" in the blank.

ITEM	NO.
Tube Tester	____
Transistor Analyzer	____
Capacitor Tester	____
VTVM	____
VOM	____
D-C Voltmeter	____
Ohmmeter	____
Multimeter	____
Wattmeter	____
A-C Ammeter (Assorted Ranges)	____
D-C Ammeter (Assorted Ranges)	____
Thermocouple Meter	____
Galvonometer	____
Wheatstone Bridge	____
Standard Potential Cell	____
Kelvin Bridge	____
Decade Resistance Box	____
Impedance Meter	____
Impedance Bridge	____
AC Bridge	____
Isolation Transformer	____
Grid Dip Meter	____
Q Meter	____
VSWR Meter	____
Sound Level Meter	____
Distortion Meter	____
Wavemeter	____
Frequency Meter	____
Signal Tracer	____
Audio Analyzer	____
Test Oscillator	____
Oscilloscope	____
Transistor Curve Tracer	____
AFC Unit	____
Signal Generator	____
Marker Generator	____

ITEM	NO.
Audio Signal Generator	____
Pulse Generator	____
Square Wave Generator	____
Linearity Generator	____
Color Bar Generator	____
Stroboscope	____
Audio Amplifier	____
Video Amplifier	____
Battery Eliminator	____
Power Supply, 0-400 Volts, 100 MA	____
Power Supply, 0-30 Volts, 250 MA	____
Variac	____
All Band Receiver	____
Slide Screw Tuner	____
Transmitter	____
Crystal Mount	____
Speaker, with Enclosure	
Parabolic Antenna	____
Dipole Antenna	____
Dummy Antenna	____
Digital Demonstrator	____
Analog Computer	____
Industrial Counter	____
Klystron Power Supply	____
Waveguide	____
Waveguide Attenuator	____
Tapping Key	____
Microphone	____
Dry Cell	____
Others (Please list below)	
______________	____
______________	____

APPENDIX L

INTERVIEW GUIDE

INTERVIEW GUIDE

SCHOOL:______________________________ DATE:____________

PERSON INTERVIEWED:____________________________________

TITLE OF PERSON INTERVIEWED:___________________________

Plans for development of physical facilities:

Are there plans for expansion of facilities? YES NO

Are the plans drawn? YES NO Approved? YES NO

Type of expansion or building program:

Comments:

Equipment

What new laboratory and/or test equipment did you get this year?

What new laboratory and/or test equipment did you get last year?

What new laboratory and/or test equipment would you like to get as soon as possible?

Do you need more hand and shop tools? YES NO
What items?

What equipment do you feel is most important for an electronic technician to be able to operate well?

Curriculum

Did you add new courses this year? YES NO What are they?

Did you add new courses last year? YES NO What are they?

Are you attempting a general change of emphasis concerning part or all of your programs? YES NO (Brief description):

Staff development:

What opportunities for professional development are available to your staff members?

How long has it been since your teachers had the opportunity to work in industry?

#1:________ #2:________ #3:________ #4:________

How long since they had the opportunity for sabbatical leave?

#1:________ #2:________ #3:________ #4:________

What should be the minimum required industrial experience for teachers in Electronic Technology programs?______ Is your staff normally on 9 months? YES NO

Would a week-end in-service training program be of any value in helping teachers on your staff keep abreast of industrial developments? YES NO

APPENDIX M

LIST OF JURY MEMBERS

Mr. Bobby Dennison
Industrial Arts Department
Southeast Central Oklahoma State College
Ada, Oklahoma 74820

Dr. Richard J. Vasek
Department of Industrial Education
Mississippi State University
State College, Mississippi

Mr. Arlie D. Patton
Institute of Electronic Science
F.E. Drawer K
College Station, Texas 77843

Dr. Charles A. Schuler
Industrial Arts Department
California State College
California, Pennsylvania

Mr. A. O. Brown
Industrial Arts Department
Kansas State College
Pittsburg, Kansas 66762

Mr. Earl Bodine
WFAA Radio
Dallas, Texas

APPENDIX N

INSTRUCTIONS FOR JURY MEMBERS

INSTRUCTIONS FOR JURY MEMBERS

This questionnaire has three purposes. First, it is intended to gather information from schools and from industries as to the degree of teaching emphasis which should be given each unit listed. School and industrial responses to each item will be compared to determine the degree of agreement. Information obtained through these comparisons should suggest possible changes which could make electronic technology curriculums more effective with respect to training students for successful employment in the industries surveyed.

The second purpose of the form is to gather estimates from schools and from industry as to the change in curricular emphasis which may take place in the near future. Spaces are provided for respondents to indicate their opinions concerning the relative importance of each unit in five years, based on the importance now. These opinions will be compared to determine whether school and industrial personnel have a similar concept of probable developments in electronics.

On the last page of the questionnaire are several questions for industrial respondents concerning the number of technicians employed and the training they need. The intent of question #1 should be evident. Question #2 is intended to provide broadly based responses concerning general areas of training, and question #3 will give some indication of the most important types of equipment to be included in technician's training.

On the form of the questionnaire going to schools the last page will be blank, because the information requested does not apply to schools. The "Hand Tool and Shop Equipment List" and the "Laboratory and Test Equipment List" will be sent instead, to provide the Texas Education Agency with current information concerning equipment which is available in these programs.

Your reaction to the materials in this packet should be given after consideration of the information in the preceding paragraphs. Kindly try to assess each form in the packet in terms of:

1. Communicability, including directions for filling out each form.
2. Correctness and completeness.
3. Practicality of the information requested in light of the purpose of the study.
4. Other suggestions you may have.

A stamped, addressed envelope is provided for your convenience in returning the materials. Thank you very much for your assistance.

APPENDIX O

COVER LETTERS FOR QUESTIONNAIRES SENT TO INDUSTRY

Electronic Technology Study — State of Texas, 1968 - 1969

Cooperating Agencies:
Texas Education Agency
Texas Engineering Experiment Station
Industrial Education Department, Texas A&M

Address Correspondence to:
Jerauld B. Wright
Drawer BD
College Station, Texas 77840

Enclosed you will find the questionnaire which is being used to gather the information for the Electronic Technology Study. Most questions you may have should be easily cleared up through examination of the directions, although these points may help you get a better "feeling" for the form and for the type of information which is desired.

1. I am interested in your point of view for the "entry level" technician--the person you would hire directly from a training program.

2. Concerning the estimates of the future importance of each unit, I realize that an estimate is an estimate. None of the material concerning these estimates will be treated as anything else.

3. The small red "card numbers" at the left of each column heading bear no importance to you as far as filling out the form. They are signals for keypunch operators, to aid them in keypunching the data for computer analysis.

4. The forms are numbered to help me keep a record of responses and to aid in the computer analysis.

I appreciate the excellent response and cooperation on the part of everyone I have contacted in regard to this study.

Please complete the form as soon as possible and return it to me in the enclosed envelope.

Sincerely,

Jerauld B. Wright
Principal Investigator

APPENDIX P

FOLLOW-UP LETTER USED DURING INDUSTRIAL SURVEY

Electronic Technology Study — State of Texas, 1968 - 1969

Cooperating Agencies:
Texas Education Agency
Texas Engineering Experiment Station
Industrial Education Department, Texas A&M

Address Correspondence to:
Jerauld B. Wright
Drawer BD
College Station, Texas 77840

Some time ago I sent you a questionnaire, to gather information from your firm for the Electronic Technology Study. Inasmuch as I have not received it back from you, I am assuming it has been mislaid or lost in the mail.

Enclosed you will find another questionnaire. I will appreciate your supplying the information requested and returning it to me in the return envelope which is also enclosed. If you have already returned the first copy, it will not be necessary to return this one.

I am assuming you would like to take part in this study, because the president of your company suggested that I contact you for the information. If your company no longer desires to participate, please let me know.

Thank you for your cooperation. I hope to hear from you soon.

Sincerely,

Jerauld B. Wright
Principal Investigator

APPENDIX Q

SUMMARY SENT TO PARTICIPATING INDUSTRIAL FIRMS

ELECTRONIC TECHNOLOGY STUDY

State of Texas, 1968-1969

A SUMMARY

Prepared for Distribution to Industrial
Companies Furnishing Data
for the Study

Prepared by Jerauld B. Wright, Principal Investigator

July 1969

FOREWORD

I would like to offer my sincere thanks to all of you who completed the rather long questionnaire used tc ··ther data for this study. The effort you put forth has made th.. project a success.

From various comments I have received in correspondence connected with this project, it seems obvious that industrial companies which participated are primarily interested in a factual summary. I have attempted to write this report around the aspects of the study that stimulated the most interest from industry, avoiding unnecessary detail as much as possible. If you need more information, I will try to provide it for you.

I will be leaving Texas A&M about the middle of August. Any correspondence after that will have to be handled by someone who was not closely associated with this study, so it would be best for all concerned if you would make inquiries as soon as possible. Any inquiries in the more distant future should be addressed to the Occupational Research Coordinating Unit, Texas Education Agency, Austin (78711).

Again, thank you for your cooperation.

Sincerely,

Jerauld B. Wright

Jerauld B. Wright
Principal Investigator

I. General Description of the Study.

Purpose.--The study was performed to provide the Texas Education Agency with information it could use in planning the development of Electronic Technology programs in Texas junior colleges. Broadly stated, the objectives were to: (1) provide an assessment of current programs, (2) provide information about the employment of electronic technicians in Texas, and (3) develop other types of information that could be used in planning, especially with regard to facilities and equipment available to the school training programs.

Sources of data.--Invited to participate in the project were (1) companies in Texas which were likely to employ electronic technicians, and (2) junior colleges which maintained Electronic Technology programs. Table 1 summarizes participation of industrial concerns.

Twenty-five junior colleges offering Electronic Technology programs were identified. Of these twenty-five, one was presently inactive, two were established this year and declined to participate because they did not feel they had progressed sufficiently to be of value to the study, three declined to participate for unidentified reasons, and nineteen took part in the study.

II. Results of the Study.

Data concerning employment of technicians.--No statistical treatment was given data concerning employment of technicians. The summary below shows total numbers reported in answer to the questions on the last page of the questionnaire. The key to the columns is as follows: R = research or testing laboratories, M = manufacturers, B = broadcasters, and T = telephone companies.

QUESTION	R	M	B	T
If well-trained technicians were available, how many would you employ?	1435	63	269	73
How many do you now employ?	3485	91	412	183
How many additional technicians do you feel you will need per year for the next five years?	1557	55	80	40
How many of the electronic technicians you now employ received their training in:				
Texas Public Jr. Colleges?	366(10.18%)	9 (9.29%)	41 (8.83%)	1 (0.48%)
Armed Forces Schools?	1627(45.24%)	50(51.55%)	78(16.81%)	20 (9.62%)
College or University Extension Programs?	303 (8.43%)	9 (9.29%)	48(10.34%)	4 (1.92%)
Correspondence Schools?	478(13.29%)	7 (7.22%)	73(15.73%)	24(11.54%)
Private Technical Schools?	633(17.60%)	14(14.43%)	187(40.30%)	16 (7.69%)
Other (Manufacturers' schools, OJT's and others)	150 (4.17%)	6 (6.19%)	28 (6.03%)	105(50.48%)
Unspecified sources[a]	39 (1.08%)	2 (2.06%)	9 (1.94%)	38(18.27%)
Totals[b]	3596	97	464	208

[a]This category was necessary because some employers did not report training sources, but did report the number of technicians employed.

[b]Totals obtained by adding numbers reported for the various training sources are not equal to total numbers of technicians reported to be employed. Apparently this is due to the fact that some technicians received training from more than one source. Percentages are based on totals obtained by adding the numbers reported for the various sources.

TABLE 1--SUMMARY OF INDUSTRIAL PARTICIPATION

Industrial Group	No. Invited to Participate	No. Which Employed Electronic Technicians and Indicated They Would Participate	No. of Usable Returns
Research and/or Testing Laboratories	558	104	78 (75.0%)
Manufacturers of Electrical and/or Electronic Equipment, which were not identified as operating research labs	311	33	15 (45.4%)
Communications Industry--Commercial Broadcasters and Telephone Companies	293 (200 Broadcasters, 93 Telephone Companies)	130 (97 Broadcasters, 33 Telephone Companies)	80 (61.5%) (59 Broadcasters, 21 Telephone Companies)

Data concerning adequacy of training.--The summary of employer's opinions of the adequacy of junior-college-trained technicians is given below. It must be noted that the total number of responses in each of the categories is not the same. The reason is that everyone did not answer all the questions on the back page of the questionnaire. (In some cases, the respondent would note that he was not acquainted with junior-college-trained technicians, and therefore felt that he could not answer.)

The data presented below was received in answer to the question: "As far as your company is concerned, junior-college-trained electronic technicians are receiving training which is:"

	Completely Adequate for our Needs				Fulfills our Needs in Most Respects				Inadequate for our Needs			
	R	M	B	T	R	M	B	T	R	M	B	T
Speaking	19	4	16	6	39	6	33	9	5	0	7	2
Reading.	22	3	15	6	36	10	30	9	6	0	9	2
Writing.	21	2	16	6	32	7	28	9	10	2	12	2
Math Related to Electronics.	12	3	10	5	43	8	34	7	8	1	12	5
Electronic Theory. . . .	10	2	11	3	36	8	28	8	17	1	17	5
Ability to perform hand skills and/or use test equipment in practical situations	7	2	10	3	27	5	35	11	26	4	25	3

It was considered significant that the largest number of "Inadequate for our needs" responses occurred in regard to the items Electronic theory and Ability to perform hand skills . . . . This correlates with the "Remarks" section of the last page of the form. Only two remarks were made more than once by any industrial group. One of these remarks was that more emphasis should be placed on practical application of subject matter. (The other was that more emphasis should be placed on digital circuitry and equipment.)

Data concerning items of equipment most important for a technician to be able to operate well.--Table 2 shows the number of times that various items of equipment were listed. To conserve space, only the most frequently listed items are given.

TABLE 2--IMPORTANT ITEMS FOR A TECHNICIAN TO BE ABLE TO OPERATE

Item	No. of times listed by R	M	B	T
Oscilloscope	66	15	42	4
Multimeter	23	2	18	5
VTVM	15	3	18	5
VOM.	15	7	15	2
Signal generator	14	5	9	1
Impedance matching devices (bridge).	12	3	3	2
Soldering iron	9	2	4	1
Pulse measuring equipment or pulse generator . . .	9	0	1	1

Specialized needs were also apparent. The broadcast industry listed "transmitters" twenty-one times, "distortion analyzers" eleven times; "video equipment" nine times, and "audio amplifiers" seven times. "Frequency counter" was listed seven times by research/testing laboratories. More than sixty other items of equipment were named three or fewer times within an industrial group. However, the list would be far too long to present here.

Analysis of data concerning curriculum.--A chi-square test of significance of independence of two variables was applied to each of the instructional units listed in the questionnaire. The test was applied three times to each unit. Test #1 was to detect differences in teaching emphasis thought necessary by school and industrial representatives. Test #2 was to detect significant differences in teaching emphasis by representatives of different industries. Finally, Test #3 was used to detect differences in the future importance estimated by school and industrial representatives.

The direction and amount of significance (in other words, which groups desired more emphasis and how much) would obviously be of interest. The best indicator of this would be a tabulation of each type of response from each industry for each unit. Such a table requires about fifty pages. In the interest of keeping this report brief and staying within limitations of the budget, the table has been omitted. Those who are interested in this extensive breakdown should contact the Texas Education Agency as suggested in the foreword of this report.

The following table was developed in an effort to provide a shorter and simpler means of presenting this data. The units which comprised the curriculum section of the questionnaire are listed in the same order as they appeared in the questionnaire. Significant differences are indicated in the columns labeled "Test 1," "Test 2," and "Test 3." To understand and properly interpret the table, it is necessary to keep these points constantly in mind:

1. The key is as follows: "S" = schools, "I" = industry (all the industries taken as one group), "R" = research and/or testing laboratories, "T" = telephone companies, "B" = commercial broadcasters, and "M" = manufacturers.

2. A letter (S,I,R,T, etc.) in one of the columns (Test 1, Test 2, or Test 3) indicates that the significant difference concerning the unit can be attributed to more of the test criterion from the source indicated by the letter. Thus, an "S" in the "Test 1" column means that schools indicated a greater degree of teaching emphasis for that unit than industry. Similarly, a "B" in the "Test 2" column shows more emphasis desired by broadcasters than by the other three industries. Finally, an "S" in the "Test 3" column shows that school representatives estimated greater future importance than industrial representatives. Combinations (for example "TB") indicate that the difference was attributed to both sources.

3. Only significant units are indicated in the columns, although all the units are listed. If the statistical test was not significant, the column is blank. If the test was significant for a unit, the source of the significance is indicated as described above.

4. In some cases a significant difference was indicated by the statistical test, but the difference was not due to a strong influence from any one source. If broadcasters, for example, were not in agreement as to the amount of emphasis a unit should be given and some stations rated the unit very high while the rest rated it very low, this disagreement could produce a difference. This was especially true if replies from one of the other sources tended toward some other distribution. These instances are shown by an asterisk (*) in the column.

5. It is important to remember that the tests were independent of each other. Each test was performed during a separate computer run, and the data cards were sorted differently for each run. Thus, a significant difference could be shown by one test but not for the others. However, this does not eliminate the possibility of making associations in cases where more than one test showed significance.

Conclusions and recommendations.--Very briefly, it was concluded that school and industrial representatives who participated in this study were not in total agreement as to the teaching emphasis which should be given the various units. They were quite closely agreed on the future importance of the units. Some differences were found in the teaching emphasis desired by spokesmen from the different industries. School and industrial spokesmen were agreed on the types of equipment a technician should be able to operate well.

It was also concluded that there is a considerable shortage of qualified electronic technicians in Texas, and that the demand for technicians will probably continue at its present level for the next five years. Junior colleges have not been a principal supplier of electronic technicians.

The term "electronic technician" apparently does not mean the same thing within the four industries represented in this project. Also, there is some discrepancy between school and industrial interpretations of this term.

Recommendations based on this study included (1) periodic repetition of this type of research; (2) closer communication between the Texas Education Agency, the colleges involved, and industry; (3) investigation into the problem of terminology mentioned above; (4) increased attempts to recruit students into Electronic Technology programs in junior colleges; and (5) consideration of experimental programs whereby teachers could periodically work in industry at a high technical level and then return to teaching. Other conclusions and recommendations were made, but these appear to be most directly related to industry-school relationships.

This brief report does not convey all the information collected by the study. Hopefully, it does provide useful data to those individuals and companies who participated in the project.

	Test 1	Test 2	Test 3
DIRECT CURRENT			
Basic Principles			
electrical resistance, voltage, and current			
prefixes (mili-, micro-, etc.)			
powers of 10			
batteries		T	
magnetic fundamentals			
series, parallel, and combination circuit theory			
D-C circuit applications			
troubleshooting D-C circuits			
Network Laws (A-C and/or D-C)			
Ohm's law			
Kirchhoff's laws	S		
power formulas			
Thevenin's theorem	S		
Norton's theorem			
Millman's theorem			
the superposition theorem			S
maximum power transfer theorem			
ALTERNATING CURRENT			
Basic Principles			
electromagnetism			
wave shapes			
electromotive force			
Vectors and Phase Relationships			
vectors and vector diagrams		B	
instantaneous values		B	
phase relationships		B	
complex numbers (J operator)	S	T	
polar coordinates	S	B	
Transformers			
theory			
turns ratio			
impedance matching	S		
transformer losses and ratios		B	
types and applications (general)			
three-phase (delta and wye connections)	I		
frequency response		B	
TEST EQUIPMENT			
Meter and Generator Usage			
basic meter movements	S		
VTVM's			
transistor voltmeters	I		
multimeters	S		
ohmmeters	S	TB	
storage oscilloscopes	I		S
laboratory oscilloscopes	S		
wavemeters	I	T	
impedance bridge	S	B	
A-C bridge	I	TB	
thermocouple meter			S
wattmeter		T	
tube testers			
transistor analyzers		B	
transistor curve tracers	*		
X-Y plotters	I		
capacitor testers			
Q meter			
frequency meter	I	B	
sine-wave generators	S		
signal generators (a-f and r-f)	S		
pulse generator	*		
square wave generator			
sweep generator	*	B	
linearity generator	I		
time mark generator	I	B	
time domain reflectometer	I		
color bar generator	I	B	*
stroboscope	I		S
digital counters			
digital voltmeters			
nuclear instruments	I		
INDUCTANCE AND CAPACITANCE			
Inductance			
self-inductance			
mutual inductance			
series and parallel			
Lenz's law			
inductive reactance	S		
instantaneous current analysis	S		S
a-f and r-f chokes		B	
Q of a coil	S	B	
Capacitance			
theory of operation			
capacitor types and rating			
effects in D-C circuits	S	T	S
R-C circuits and time constants			
capacitive reactance	S		
bypass capacitor effect		*	
R-L-C Circuits			
series R-L-C circuits	S		
parallel R-L-C circuits	S		
phase relationships and effects of varying circuit properties			
Parallel, Series Resonant Circuits			
resonant circuit "Q"	S		
analysis of series and parallel resonant circuits	S		
resonant circuit bandwidth	S		
applications of resonant circuits	S	B	
frequency response curves	S	TB	
resonant filters	S	B	

	Test 1	Test 2	Test 3
VACUUM TUBES			
Fundamentals			
early development and use			
emitter materials			
types of envelopes and bases		*	
types of emission	S		
cathodes; directly and indirectly heated		*	
Diodes			
characteristic curves	S	T	
rectification, detection	S	T	
Triodes			
biasing methods, positive and negative	S	*	
load lines	S	B	
saturation	S	B	
interelectrode capacitance	S	TB	
transconductance, plate resistance, amplification factor	S	B	
static and dynamic characteristic curves	S		
transfer curves	S	B	
voltage amplification	S	B	
equivalent circuits		B	
Tetrodes			
interelectrode capacitance		B	
effect of screen grid		B	
effects of secondary emission		B	
plate and screen characteristic curves	S	B	
Pentodes			
effects of suppressor grid	S	B	
plate and dynamic characteristic curves	S	B	
tube parameters	S	B	
sharp and remote cutoff characteristics		B	
beam power tubes		B	
Multigrid Tubes			
pentagrid converters		B	
pentagrid mixers		B	
Special Application Tubes			
multisection tubes		B	
subminiature tubes		B	
gas-filled regulators		T	
thyratron tubes			
ignitrons		*	
phototubes			
photo-multiplier tubes	I		
electron-ray indicators			
cathode-ray tubes	S		
high frequency tubes		B	
klystrons		B	
SEMICONDUCTORS			
Fundamentals			
early development and usage			

	Test 1	Test 2	Test 3
atomic structure	S		
crystal structure	S		
bonds	S		
impurities	S		
classification			S
electrons and hole charges	S		
Semiconductor Diodes			
color code			
PN junctions	S		
forward and reverse bias	S		
characteristic curves	S		
types of diodes (point-contact, tunnel, zener, photo, etc.)			
silicon controlled rectifiers and switches			
variable-capacitance diodes	I		
hall generators	I		
TRANSISTORS			
Construction and Characteristics			
transistor fabrication		B	
configurations	S		
current gain	S		
junction type transistors			
static characteristic curves	S		
dynamic transfer curves	S		
transistor biasing	S		
physical circuit operation (NPN and PNP)	S		
load lines	S	*	
graphical analysis	S	*	
thermal properties			
operating point	S		
transistor noise			
"r" parameter	I	B	
hybrid parameters		B	
Special Purpose Transistors			
tetrode transistors		B	
photosensitive transistors			
power transistors			
unijunction transistors		B	
field-effect transistors			
thyristors			
microcircuits (including integrated circuits)	I	B	
BASIC CIRCUITS AND SYSTEMS			
Power Supplies			
half and full wave rectifiers	S		
principles of filtering	S		
voltage dividers and doublers			
polyphase power supplies	I		
r-f power supplies	I	TB	
voltage-regulator circuits			
power supply troubleshooting			

	Test 1	Test 2	Test 3
Amplifier Fundamentals----------			
biasing and classes of operation (A, B, C, etc.)			
decibels		TB	
stereophonic sound		B	
D-C amplifier gain			
A-C amplifier gain			
magnetic amplifiers	I		
frequency response	S	B	
Basic Vacuum Tube Amplifiers and Circuits-------------------			
paraphase amplifiers	*	TB	
cathode follower a-f			
push-pull a-f amplifiers		B	
i-f amplifiers		B	
amplifier coupling	S	B	
audio preamplifier circuits		TB	
audio-output stage		TB	
tone control circuits		T	
bandpass amplifier circuits	S	TB	
attenuators		TB	
delayed-action circuits		B	
Loudspeakers-------------------			
headsets		*	
dynamic speakers		TB	
electrostatic speakers		*	I
P-M speakers		B	
speaker enclosures		B	
Microphones and Pickups----------			
carbon		*	
capacitor		B	
crystal		T	
dynamic		TB	
velocity		TB	
ceramic		TB	
Oscillators----------------------			
phase-shift oscillators	S		
tuned plate-grid oscillators	S	TB	
Hartley oscillators	S		
Colpitts oscillators	S		
Armstrong oscillators	S		
electron-coupled oscillators	S	B	
Pierce oscillators			
crystal overtone oscillators	*	B	
R-F Amplifiers and Circuits---			
r-f amplifier circuits (general)	S	TB	
r-f power amplifiers	S	TB	
wide-band amplifiers	S	TB	
single and double tuned circuits	S	B	S
neutralizing circuits		B	
r-f buffer and frequency multipliers		B	
troubleshooting procedures		B	
Transmitter Fundamentals--------			
c-w transmitter keying	S	TB	
classification of wave emission	S	TB	

	Test 1	Test 2	Test 3
parasitics and harmonics		B	
power distribution in a-m waves	S	TB	
transmitter measurements		B	
a-m, f-m comparisons		B	
transmitter alignment		B	
Radio Transmitter and Circuits-			
c-w transmitters	S	T	
vhf transmitters		B	
uhf transmitters		B	
a-m transmitters and circuits	S	B	
sideband transmitters		B	
f-m (reactance tube) transmitters		B	
f-m (phase) transmitters		B	
troubleshooting procedures		B	
Transmission of Radio Waves----			
principles of radiation and propagation		B	
antenna fundamentals		B	S
transmission line theory		B	
types of antennas		B	
FCC regulations		TB	
Radio Receiver Fundamentals----			
reading schematic diagrams		B	
heterodyning principles	S	B	
a-m detection	S	B	
f-m detection	S	B	
alignment procedures	S	TB	
troubleshooting procedures		TB	
Radio Receivers and Circuits---			
T-R-F receivers		T	
superhet receivers (general)	S	B	
am-fm receivers	S	B	
sideband receivers	S	B	
special receiver circuits		TB	
AVC circuits	S	TB	
the B+ supply	S	TB	
squelch circuits		TB	
limiters	S	B	
discriminators	S	TB	
TRANSISTOR CIRCUITS			
Transistor Amplifier Fundamentals-------------------------			
reading transistor specifications		B	
classes of operation			
current, voltage, and power gain			
base, emitter, collector phase relationships			
input and output resistance	S		
volume and tone controls		TB	I
effects of feedback	S		
equivalent circuits			
transistor measurements			
troubleshooting procedures			

	Test 1	Test 2	Test 3
Transistor Amplifiers and Circuits-------------------------			
common emitter, collector, and base configurations	S		
push-pull amplifiers			
cascade audio amplifiers			
R-C coupled audio amplifiers			
transformer coupled amplifiers	S		
direct coupled amplifiers			
power amplifiers			
tuned amplifiers			
reflex amplifiers	I		
D-C amplifiers			
r-f and i-f amplifiers		B	
wide-band amplifiers		B	
preamplifiers		B	
phase inverters			
bridge arrangements			
symmetry circuits		B	
transistor current regulators			
transistor voltage regulators			
bias circuits			
printed circuits			
Transistor Receivers------------			
power supplies			
oscillators			
modulation, mixing, and detection circuits			
agc circuits			
ADVANCED CIRCUITS AND SYSTEMS			
Nonsinusoidal Waveshapes---------			
square waves	S	B	
rectangular waves	S	B	
sawtooth waves	S	B	
triangular and peaked waves	S	B	
multi-segmented waves		B	
curved wave forms	S	B	
transients	S	RT	
D-C components of waveforms	S	B	
A-C components of waveforms	S	B	
waveform generation	S	B	
Pulse and Switching Circuits----			
diode and triode switching circuits	S		
free running multivibrators	S		
bistable multivibrators	S		
monostable multivibrators	S		
astable multivibrators	S	B	
blocking oscillators	S		
shock-excited oscillators	S		
gas-tube relaxation oscillators	*		
gating circuits	S		
delay circuits	S		
saturable-core reactor circuits	I		
pulse generators		B	
triggering circuits			
pulse counters		BM	
logic circuits		RB	
pulse amplifiers		RB	
linear wave shaping			
binary systems	S	RB	
decimal systems		B	
null detectors	*		
Digital Computer Fundamentals--			
computer applications		B	
computer programming		B	
computer math		B	
adders and subtractors		TB	
methods of data storage		B	
analog-to-digital conversion		TB	
Limiters, Clampers, Counters---			
diode limiters	S		
triode limiters	*	B	
diode clamping	S		
counters (frequency divider)	S	B	
diode clippers	S	B	
Sweep-Generator Circuits-------			
sawtooth-wave form circuits	S	B	
gas-tube sweep generator circuits	*	*	
vacuum-tube sweep generator circuits			
transistor sweep generator circuits	*	B	
sweep expansion and delay circuits		B	
TV Transmitters and Receivers-			
frequency bands		B	
standard interlaced scanning		B	
composite TV picture signal		B	
camera tubes		B	
TV image and image resolution		B	
TV transmitter functional analysis		B	
TV receiver functional analysis		B	
MICROWAVE ELECTRONICS			
Microwave Transmission--------			
communications transmitters	I	B	
radar transmitters	I	B	
generating microwave signals		TB	
cavity resonators		TB	
waveguides		TB	
duplexers		TB	
microwave antennas		TB	
transmission lines		TB	
wavelength measurement		TB	
Special Amplifiers------------			
grounded-grid amplifiers		B	
video amplifiers	I	B	
D-C amplifiers	I	B	
traveling-wave amplifiers	I	B	*
parametric amplifiers		B	*

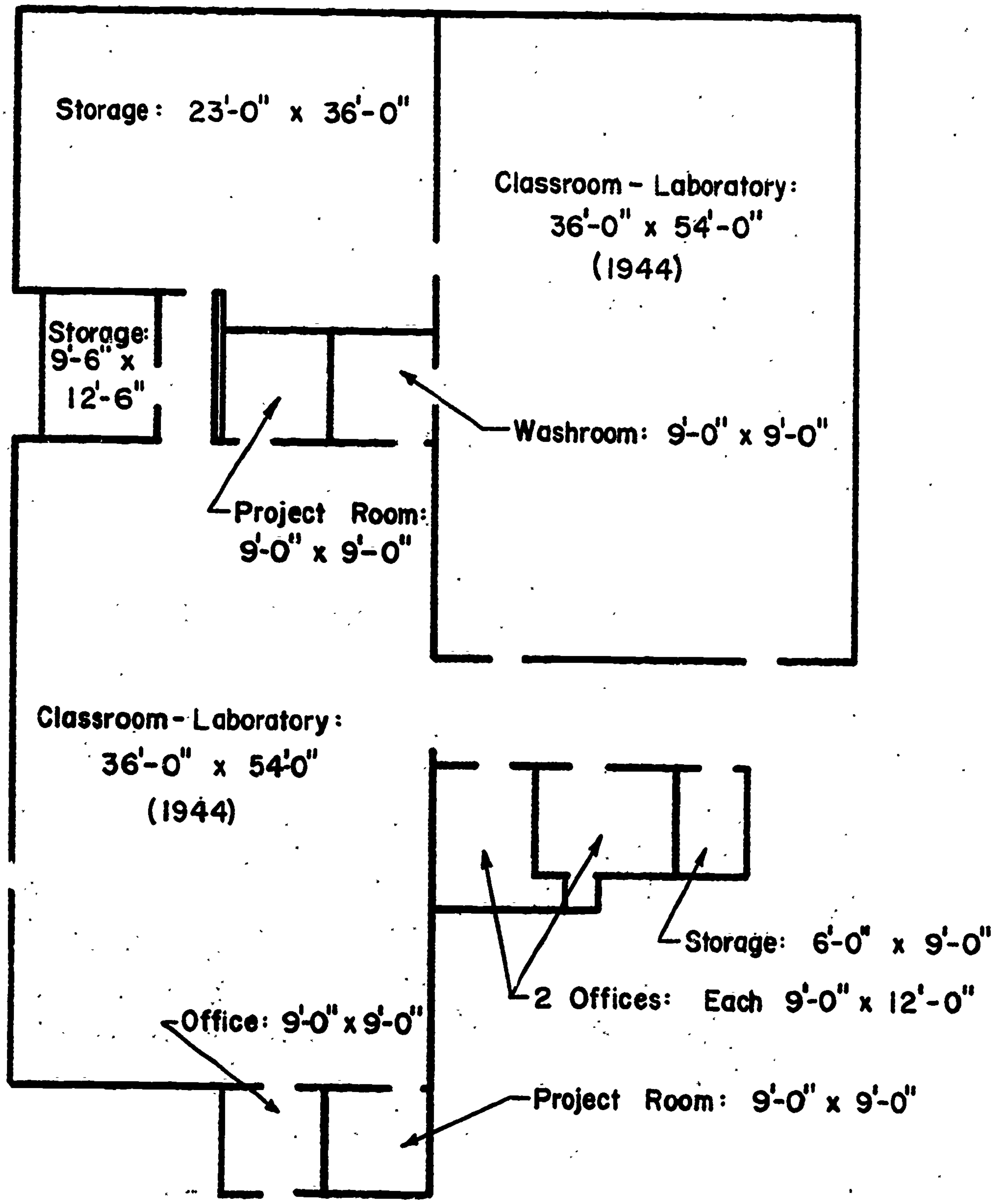
(10)

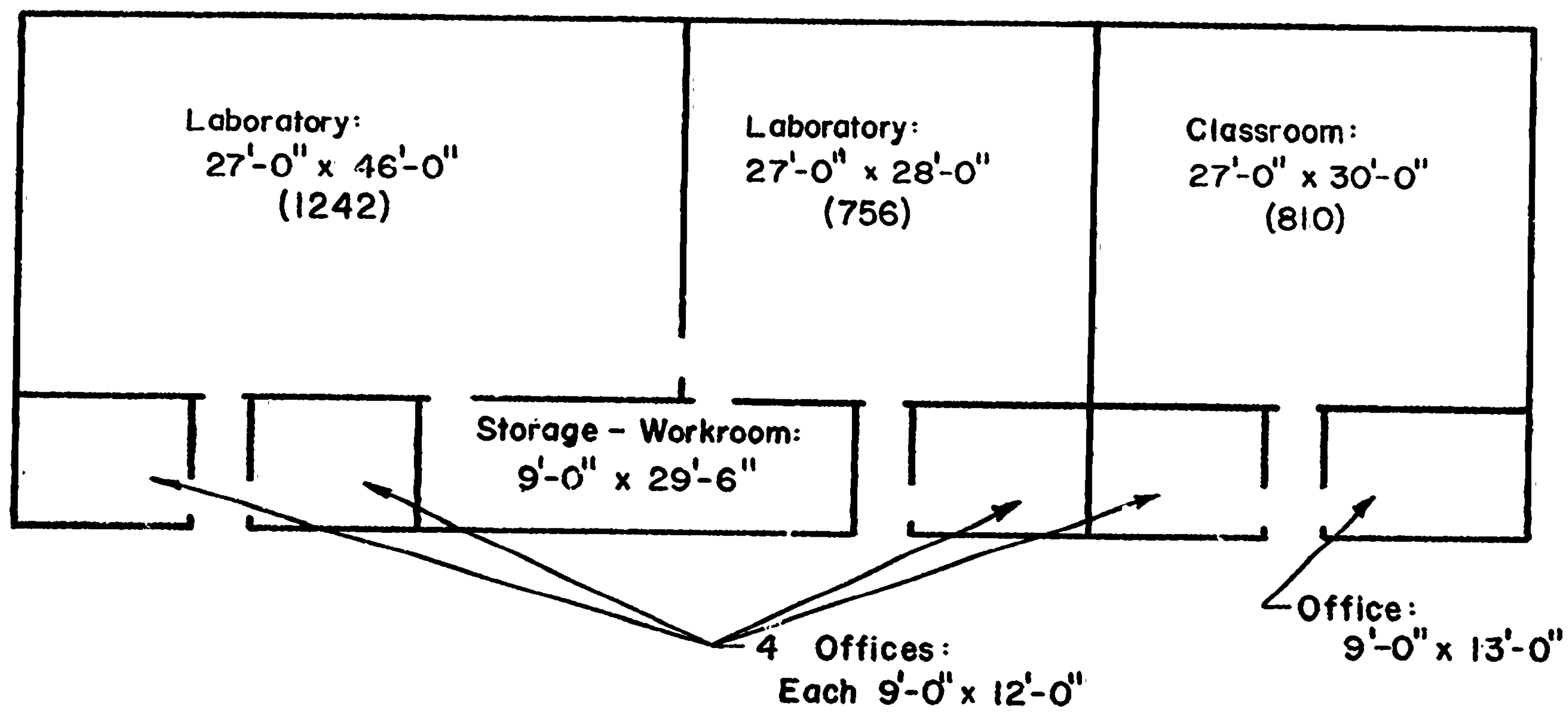
	Test 1	Test 2	Test 3
masers	I	B	
lasers	I	B	I
Miscellaneous (microwave)----------			
backward-wave oscillators		*	
microwave mixers	I	*	
using Smith chart		B	
Microwave Receivers----------			
communications receiver		TB	
radar receiver		B	
Multiplexing----------			
time-division multiplexing principles	I		
time-division multiplex transmitter and receiver analysis	I	B	
frequency-division multiplexing principles	I	B	
frequency-division multiplex transmitter and receiver analysis	I	B	
Microwave Measurements----------			
attenuation measurements	I	TB	
power measurements	*	TB	
reflectometer measurements	I	TB	
frequency measurements		TB	
phase-shift measurements		TB	
measurement of Q		TB	
noise measurements	I	TB	
dielectric measurements	I	TB	
impedance measurements		TB	
directional couplers		TB	
absorption wavemeter		TB	
VSWR measurements		TB	
coaxial-cable measurements		TB	
propagation patterns		TB	*
Radar System Principles----------			
block diagram analysis	I	B	
CRT types		B	
radar sweep chains	I	B	
range-mark generator chains	I	B	
delay devices in radar systems	I	B	
radar modulators	I	B	
magnetrons		B	
Navigational Electronics----------			
sonar		B	
loop antennas		*	
radio direction finders		B	
loran		B	
OTHER APPLICATIONS OF ELECTRONIC DEVICES			
Generators and Motors (Types and Theory)----------			
A-C and D-C generators			
A-C and D-C motors			
single-phase principles			
three-phase principles	I		

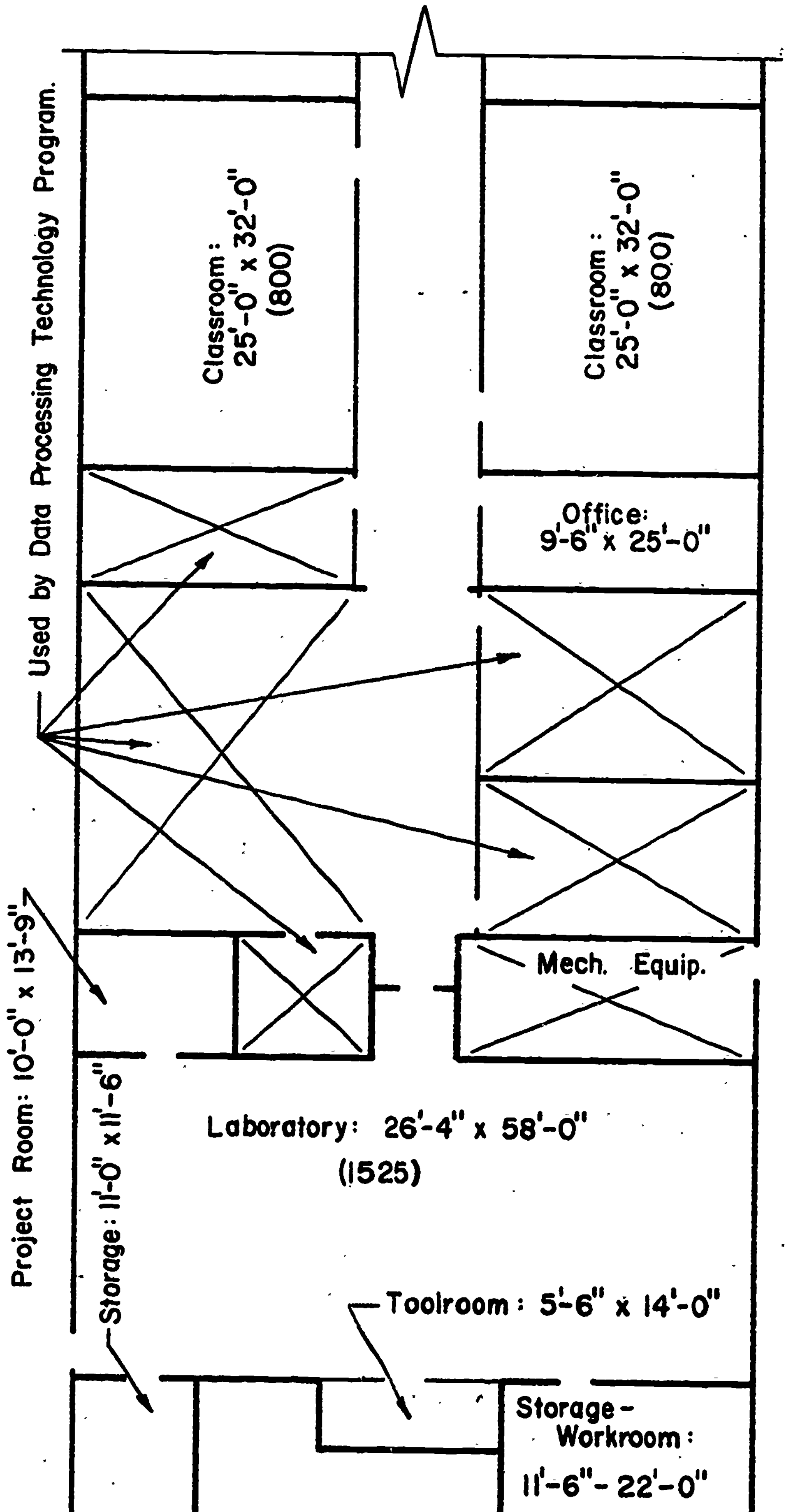
	Test 1	Test 2	Test 3
converters, inverters, and dynamotors	I		
generator and motor maintenance	I		
speed regulators	I		
automatic motor controls			
Synchros and Control Systems----------			
synchro applications			
synchro principles			
differential synchro	*		
synchro control transformer	*		
geared synchro systems			
synchro capacitors	I		
synchro connections	*		
Servo Control Devices and Systems----------			
fundamental servo principles			
common servomechanism systems			
servomechanism chains	I		
frequency response of servo systems	I		
Industrial Electronic Applications and Devices----------			
decision or intelligence devices	I		I
electronic control systems			
simple electronic circuits	*		S
ultrasonics	I		
electronic heating and welding			
transducers	*		
thermistors	S		
temperature recorders			
varistors	*		
time-delay relays	I	*	
large-current polyphase rectifiers			
high frequency wavelengths		B	
high-speed light and register controls	I		
thyratron controls			
electronic timer circuits	I		
radiation inspection and detection			
photoelectric devices	*		

APPENDIX R

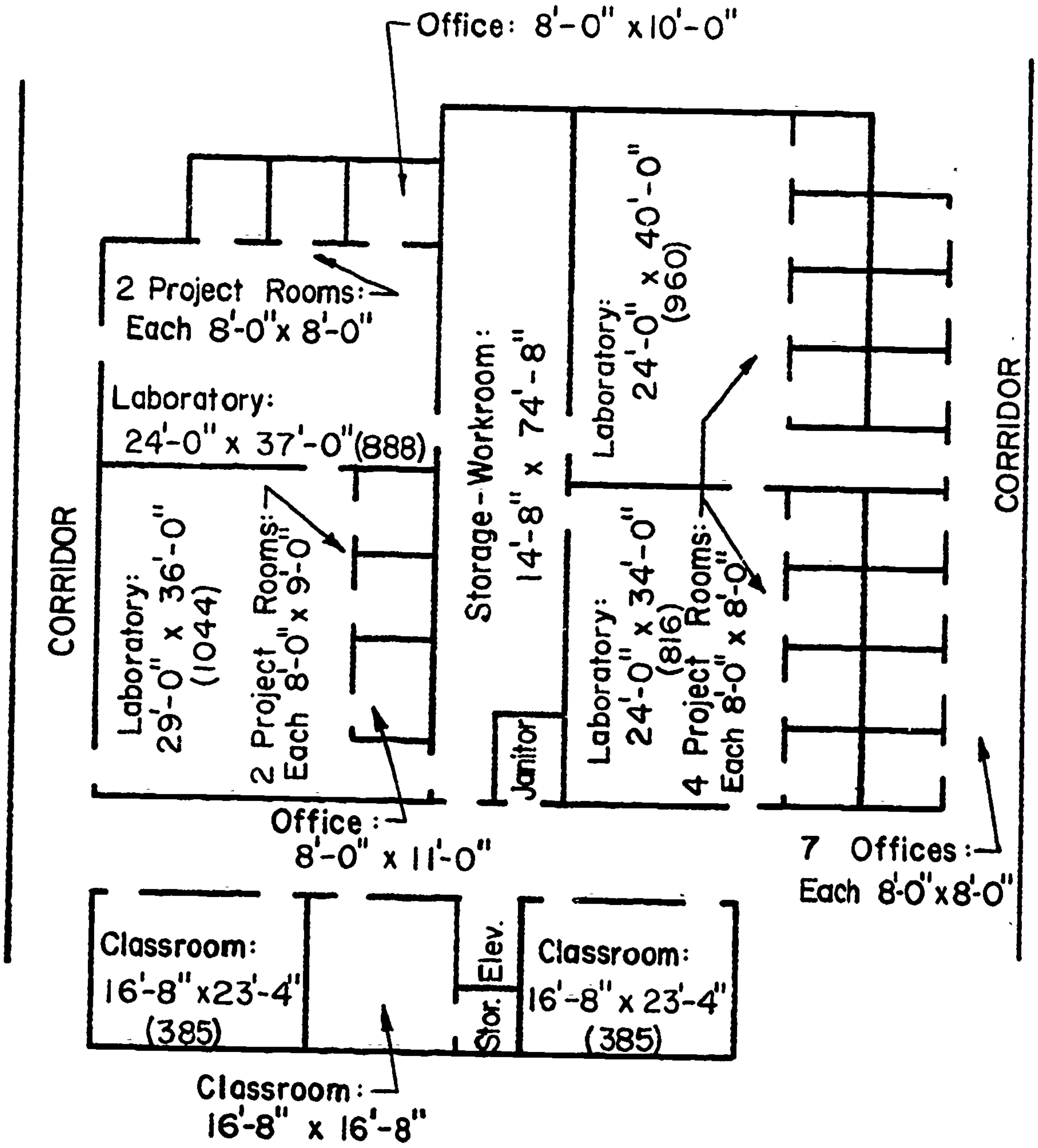
FLOOR PLANS FROM SEVEN SCHOOLS

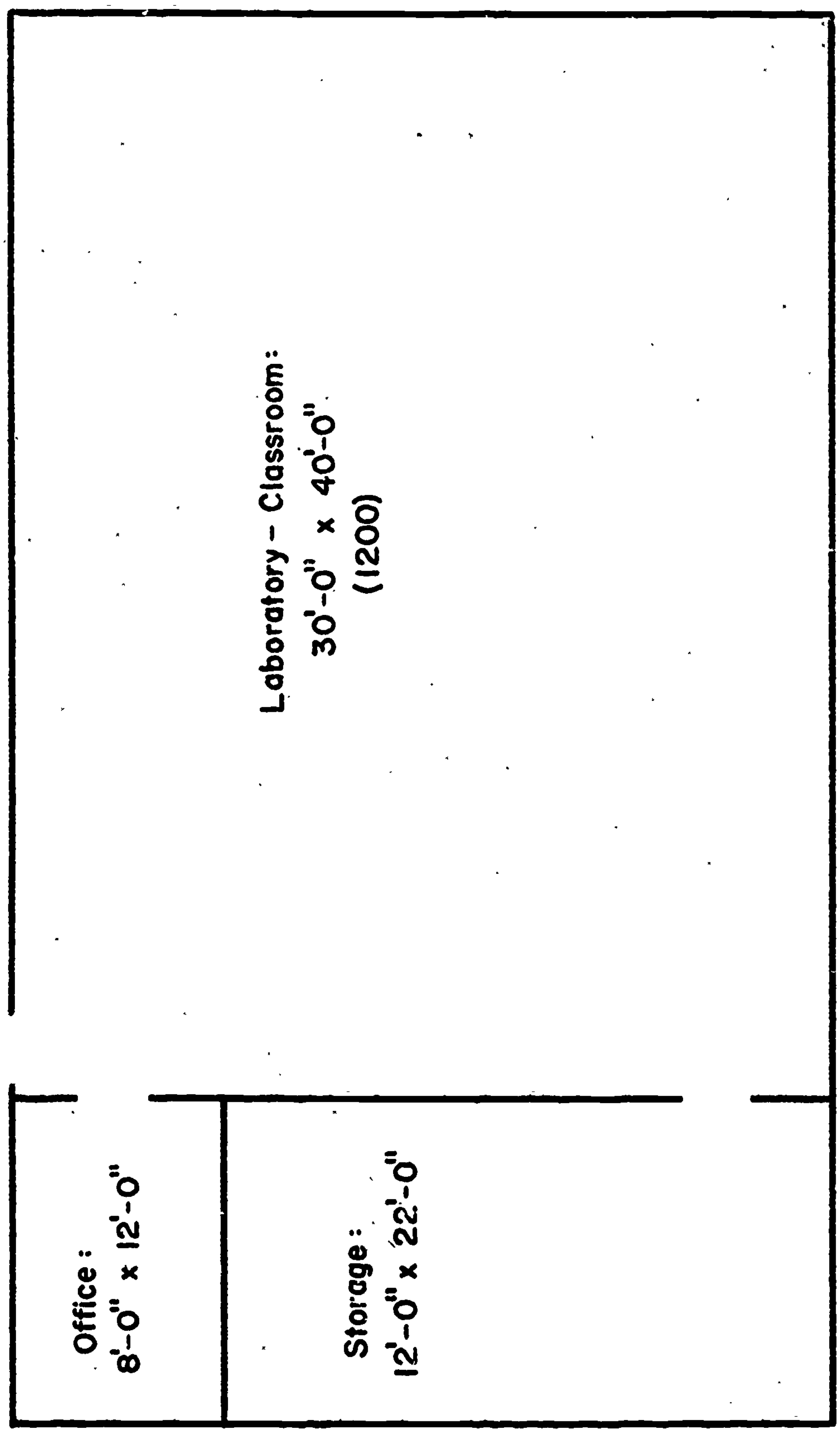

Storage: 23'-0" x 36'-0"
Classroom - Laboratory: 36'-0" x 54'-0" (1944)
Storage: 9'-6" x 12'-6"
Washroom: 9'-0" x 9'-0"
Project Room: 9'-0" x 9'-0"
Classroom - Laboratory: 36'-0" x 54'-0" (1944)
Storage: 6'-0" x 9'-0"
2 Offices: Each 9'-0" x 12'-0"
Office: 9'-0" x 9'-0"
Project Room: 9'-0" x 9'-0"

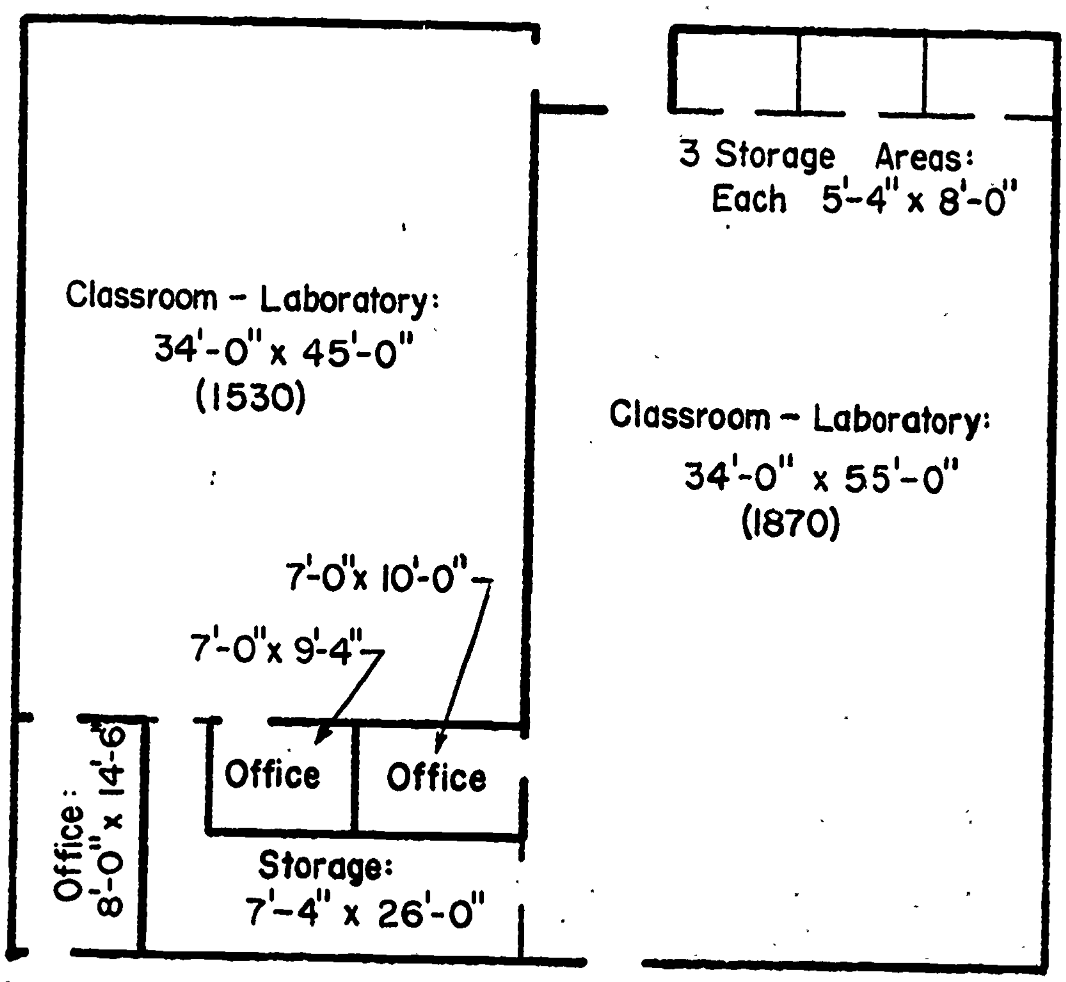

Laboratory:
27'-0" x 46'-0"
(1242)
Laboratory:
27'-0" x 28'-0"
(756)
Classroom:
27'-0" x 30'-0"
(810)
Storage - Workroom:
9'-0" x 29'-6"
4 Offices:
Each 9'-0" x 12'-0"
Office:
9'-0" x 13'-0"

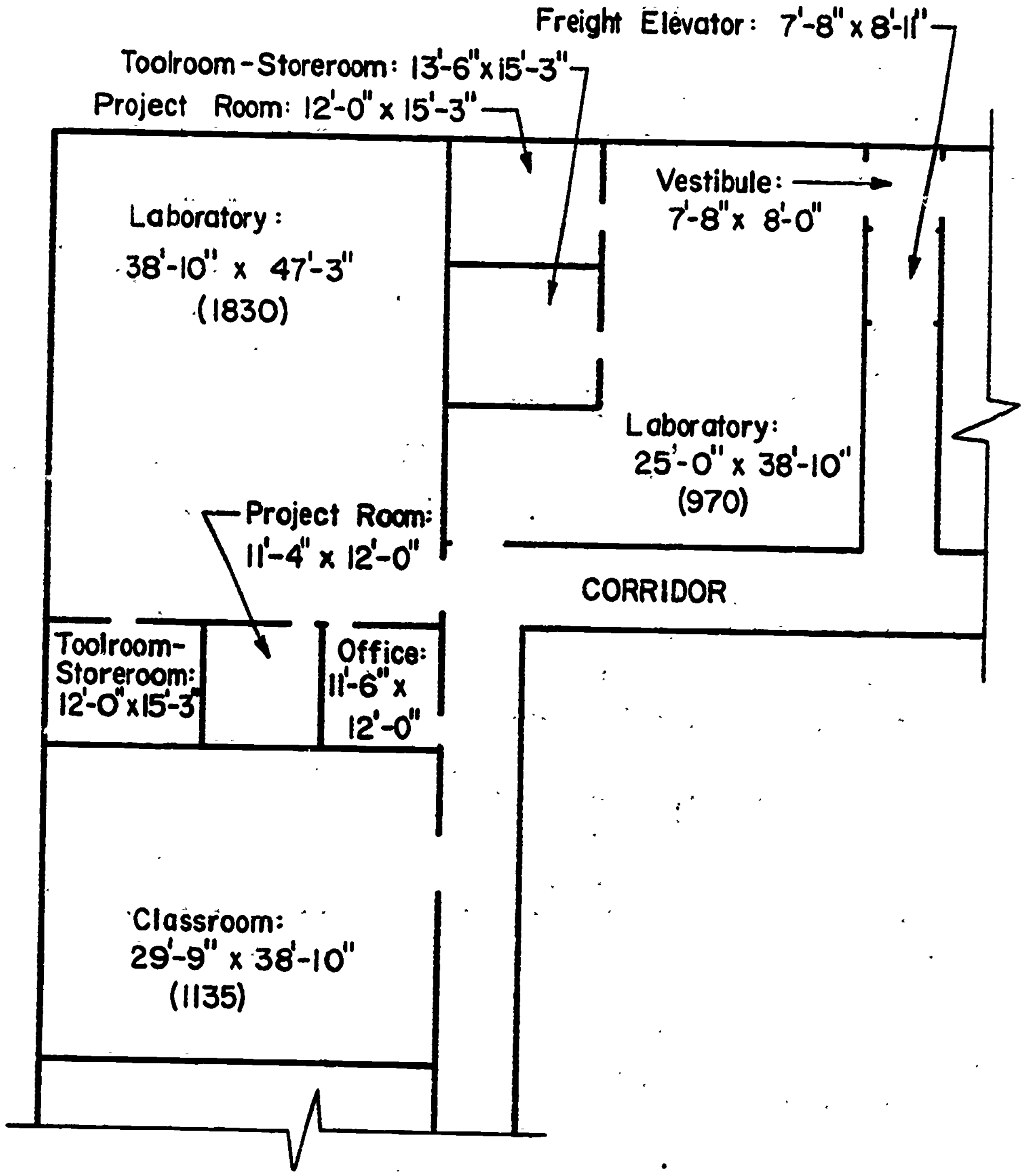


Used by Data Processing Technology Program.
Classroom: 25'-0" x 32'-0" (800)
Classroom: 25'-0" x 32'-0" (800)
Office: 9'-6" x 25'-0"
Mech. Equip.
Project Room: 10'-0" x 13'-9"
Storage: 11'-0" x 11'-6"
Laboratory: 26'-4" x 58'-0" (1525)
Toolroom: 5'-6" x 14'-0"
Storage - Workroom: 11'-6"-22'-0"


Office: 8'-0" x 10'-0"
2 Project Rooms: Each 8'-0" x 8'-0"
Laboratory: 24'-0" x 37'-0" (888)
CORRIDOR
Laboratory: 29'-0" x 36'-0" (1044)
2 Project Rooms: Each 8'-0" x 9'-0"
Storage-Workroom: 14'-8" x 74'-8"
Laboratory: 24'-0" x 40'-0" (960)
Laboratory: 24'-0" x 34'-0" (816)
4 Project Rooms: Each 8'-0" x 8'-0"
Janitor
CORRIDOR
Office: 8'-0" x 11'-0"
7 Offices: Each 8'-0" x 8'-0"
Classroom: 16'-8" x 23'-4" (385)
Elev.
Stor.
Classroom: 16'-8" x 23'-4" (385)
Classroom: 16'-8" x 16'-8"


Laboratory - Classroom:
30'-0" x 40'-0"
(1200)
Office:
8'-0" x 12'-0"
Storage:
12'-0" x 22'-0"


3 Storage Areas:
Each 5'-4" x 8'-0"
Classroom - Laboratory:
34'-0" x 45'-0"
(1530)
Classroom - Laboratory:
34'-0" x 55'-0"
(1870)
7'-0" x 10'-0"
7'-0" x 9'-4"
Office
Office
Office: 8'-0" x 14'-6"
Storage:
7'-4" x 26'-0"


Freight Elevator: 7'-8" x 8'-11"
Toolroom-Storeroom: 13'-6" x 15'-3"
Project Room: 12'-0" x 15'-3"
Laboratory:
38'-10" x 47'-3"
(1830)
Vestibule:
7'-8" x 8'-0"
Laboratory:
25'-0" x 38'-10"
(970)
Project Room:
11'-4" x 12'-0"
CORRIDOR
Toolroom-
Storeroom:
12'-0" x 15'-3"
Office:
11'-6" x
12'-0"
Classroom:
29'-9" x 38'-10"
(1135)

APPENDIX S

TABULATION OF RESPONSES

TABLE 11

TABULATION OF RESPONSES[a]

Units		Taught in Depth		Emphasized		Discussed Briefly		Not Taught	
		No.	%	No.	%	No.	%	No.	%
DIRECT CURRENT									
Basic Principles:									
Electrical Resistance,	R (78)	69	88.5	8	10.3	0	0.0	1	1.3
Voltage, and Current	T (21)	20	95.2	1	4.8	0	0.0	0	0.0
	B (59)	55	93.2	4	6.8	0	0.0	0	0.0
	M (15)	14	93.3	1	6.7	0	0.0	0	0.0
	Totals (173)	158	91.4	14	8.1	0	0.0	1	0.5

[a]This table shows the total number of times each of the four degrees of teaching emphasis was checked by each participating industrial group, for each of the 421 units listed in the Information Form. For the first unit (Electrical Resistance, Voltage, and Current), the first line of the table shows that 69 of the 78 research laboratories checked "Taught in Depth." This is a proportion of 88.5 per cent. Eight research laboratories (10.3 per cent) checked "Emphasized" for this unit. None of the research laboratories checked "Discussed Briefly." One (1.3 per cent) checked "Not Taught." The second line (T) shows replies from the 21 telephone companies. The third line (B) summarizes replies from the 55 commercial broadcasters, and the fourth line (M) shows responses from the 15 manufacturers. Totals for all industries combined appear on the fifth line. This format is repeated for each unit.

TABLE 11--Continued

Units		Taught in Depth No.	Taught in Depth %	Emphasized No.	Emphasized %	Discussed Briefly No.	Discussed Briefly %	Not Taught No.	Not Taught %
Prefixes (mili-, micro-, etc.)	R (78)	43	55.1	27	34.6	8	10.3	0	0.0
	T (21)	11	52.4	5	23.8	4	19.0	1	4.8
	B (59)	29	49.2	20	33.9	9	15.3	1	1.7
	M (15)	7	46.7	5	33.3	3	20.0	0	0.0
	Totals (173)	90	52.1	57	32.9	24	13.9	2	1.1
Powers of 10	R (78)	40	51.3	27	34.6	11	14.1	0	0.0
	T (21)	8	38.1	8	38.1	5	23.8	0	0.0
	B (59)	24	40.7	23	39.0	10	16.9	2	3.4
	M (15)	6	40.0	6	40.0	2	13.3	1	6.7
	Totals (173)	78	45.1	64	37.0	28	16.2	3	1.7
Batteries	R (78)	19	24.4	26	33.3	32	41.0	1	1.3
	T (21)	10	47.6	9	42.9	1	4.8	1	4.8
	B (59)	9	15.3	29	49.2	19	32.2	2	3.4
	M (15)	2	13.3	7	46.7	6	40.0	0	0.0
	Totals (173)	40	23.1	71	41.0	58	33.6	4	2.3
Magnetic Fundamentals	R (78)	33	42.3	31	39.7	13	16.7	1	1.3
	T (21)	11	52.4	10	47.6	0	0.0	0	0.0
	B (59)	30	50.8	23	39.0	5	8.5	1	1.7
	M (15)	5	33.3	7	46.7	2	13.3	1	6.7
	Totals (173)	79	45.6	71	41.0	20	11.6	3	1.7

TABLE 11--Continued

Units		Taught in Depth No.	Taught in Depth %	Empha-sized No.	Empha-sized %	Discussed Briefly No.	Discussed Briefly %	Not Taught No.	Not Taught %
Series, Parallel, and Combination Circuit Theory	R (78)	62	79.5	15	19.2	1	1.3	0	0.0
	T (21)	18	85.7	3	14.3	0	0.0	0	0.0
	B (59)	43	72.9	14	23.7	1	1.7	1	1.7
	M (15)	9	60.0	6	40.0	0	0.0	0	0.0
	Totals (173)	132	76.3	38	21.9	2	1.2	1	0.6
D-C Circuit Applications	R (78)	45	57.7	31	39.7	2	2.6	0	0.0
	T (21)	18	85.7	3	14.3	0	0.0	0	0.0
	B (59)	39	66.1	19	32.2	1	1.7	0	0.0
	M (15)	10	66.7	4	26.7	1	6.7	0	0.0
	Totals (173)	112	64.8	57	32.9	4	2.3	0	0.0
Troubleshooting D-C Circuits	R (78)	39	50.0	33	42.3	4	5.1	2	2.6
	T (21)	17	81.0	4	19.0	0	0.0	0	0.0
	B (59)	34	57.6	20	33.9	3	5.1	2	3.4
	M (15)	11	73.3	3	20.0	0	0.0	1	6.7
	Totals (173)	101	58.4	60	34.7	7	4.0	5	2.9
Network Laws (A-C and/or D-C): Ohm's Law	R (78)	69	88.5	9	11.5	0	0.0	0	0.0
	T (21)	17	81.0	4	19.0	0	0.0	0	0.0
	B (59)	49	83.1	8	13.6	2	3.4	0	0.0
	M (15)	13	86.7	2	13.3	0	0.0	0	0.0
	Totals (173)	148	85.5	23	13.3	2	1.2	0	0.0

TABLE 11--Continued

Units		Taught in Depth No.	Taught in Depth %	Emphasized No.	Emphasized %	Discussed Briefly No.	Discussed Briefly %	Not Taught No.	Not Taught %
Kirchhoff's Laws	R (78)	48	61.5	23	29.5	6	7.7	1	1.3
	T (21)	14	66.7	6	28.6	1	4.8	0	0.0
	B (59)	29	49.2	23	39.0	7	11.9	0	0.0
	M (15)	9	60.0	6	40.0	0	0.0	0	0.0
	Totals (173)	100	57.8	58	33.5	14	8.1	1	0.6
Power Formulas	R (78)	44	56.4	24	30.8	10	12.8	0	0.0
	T (21)	11	52.4	8	38.1	2	9.5	0	0.0
	B (59)	33	55.9	20	33.9	6	10.1	0	0.0
	M (15)	8	53.3	6	40.0	1	6.7	0	0.0
	Totals (173)	96	55.5	58	33.5	19	11.0	0	0.0
Thevenin's Theorem	R (78)	29	37.2	20	25.6	22	28.2	7	9.0
	T (21)	3	14.3	8	38.1	9	42.9	1	4.8
	B (59)	8	13.6	27	45.8	21	35.6	3	5.1
	M (15)	4	26.7	6	40.0	3	20.0	2	13.3
	Totals (173)	44	25.4	61	35.3	55	31.8	13	7.5
Norton's Theorem	R (78)	23	29.5	20	25.6	25	32.1	10	12.8
	T (21)	2	9.5	8	38.1	9	42.9	2	9.5
	B (59)	6	10.1	26	44.1	23	39.0	4	6.8
	M (15)	3	20.0	4	26.7	4	26.7	4	26.7
	Totals (173)	34	19.6	58	33.5	61	35.3	20	11.6

TABLE 11--Continued

Units		Taught in Depth No.	Taught in Depth %	Emphasized No.	Emphasized %	Discussed Briefly No.	Discussed Briefly %	Not Taught No.	Not Taught %
Millman's Theorem	R (78)	15	19.2	20	25.6	29	37.2	14	17.9
	T (21)	2	9.5	8	38.1	9	42.9	2	9.5
	B (59)	6	10.1	24	40.7	25	42.3	4	6.8
	M (15)	2	13.3	4	26.7	6	40.0	3	20.0
	Totals (173)	25	14.4	56	32.4	69	39.9	23	13.3
The Superposition Theorem	R (78)	20	25.6	25	32.1	25	32.1	8	10.3
	T (21)	2	9.5	8	38.1	9	42.9	2	9.5
	B (59)	7	11.9	27	45.8	21	35.6	4	6.8
	M (15)	1	6.7	5	33.3	6	40.0	3	20.0
	Totals (173)	30	17.3	65	37.7	61	35.2	17	9.8
Maximum Power Transfer Theorem	R (78)	18	23.1	32	41.0	22	28.2	6	7.7
	T (21)	4	19.0	11	52.4	5	23.8	1	4.8
	B (59)	16	27.1	28	47.5	12	20.3	3	5.1
	M (15)	2	13.3	6	40.0	5	33.3	2	13.3
	Totals (173)	40	23.1	77	44.6	44	25.4	12	6.9
ALTERNATING CURRENT									
Basic Principles:									
Electromagnetism	R (78)	41	52.6	35	44.9	2	2.6	0	0.0
	T (21)	14	66.7	5	23.8	2	9.5	0	0.0
	B (59)	31	52.5	24	40.7	4	6.8	0	0.0
	M (15)	7	46.7	6	40.0	1	6.7	1	6.7
	Totals (173)	93	53.8	70	40.5	9	5.2	1	0.6

TABLE 11--Continued

Units		Taught in Depth No.	Taught in Depth %	Emphasized No.	Emphasized %	Discussed Briefly No.	Discussed Briefly %	Not Taught No.	Not Taught %
Wave Shapes	R (78)	47	60.3	25	32.1	5	6.4	1	1.3
	T (21)	9	42.9	10	47.6	2	9.5	0	0.0
	B (59)	32	54.2	23	39.0	4	6.8	0	0.0
	M (15)	6	40.0	7	46.7	2	13.3	0	0.0
	Totals (173)	94	54.3	65	37.6	13	7.5	1	0.6
Electromotive Force	R (78)	36	46.2	34	43.6	8	10.3	0	0.0
	T (21)	12	57.1	7	33.3	2	9.5	0	0.0
	B (59)	27	45.8	28	47.5	4	6.8	0	0.0
	M (15)	6	40.0	5	33.3	3	20.0	1	6.7
	Totals (173)	81	46.8	74	42.8	17	9.8	1	0.6
Vectors and Phase Relationships:									
Vectors and Vector Diagrams	R (78)	29	37.2	32	41.0	17	21.8	0	0.0
	T (21)	6	28.6	9	42.9	5	23.8	1	4.8
	B (59)	39	66.1	16	27.1	4	6.8	0	0.0
	M (15)	1	6.7	11	73.3	2	13.3	1	6.7
	Totals (173)	75	43.4	68	39.3	28	16.2	2	1.2
Instantaneous Values	R (78)	25	32.1	37	47.4	16	20.5	0	0.0
	T (21)	6	28.6	7	33.3	7	33.3	1	4.8
	B (59)	26	44.1	27	45.8	6	10.1	0	0.0
	M (15)	1	6.7	11	73.3	3	20.0	0	0.0
	Totals (173)	58	33.5	82	47.4	32	18.5	1	0.6

TABLE 11--Continued

Units		Taught in Depth No.	Taught in Depth %	Emphasized No.	Emphasized %	Discussed Briefly No.	Discussed Briefly %	Not Taught No.	Not Taught %
Phase Relationships	R (78)	33	42.3	31	39.7	13	16.7	1	1.3
	T (21)	9	42.9	6	28.6	6	28.6	0	0.0
	B (59)	38	64.4	18	30.5	3	5.1	0	0.0
	M (15)	4	26.7	10	66.7	1	6.7	0	0.0
	Totals (173)	84	48.6	65	37.6	23	13.3	1	0.6
Complex Numbers (J Operator)	R (78)	17	21.8	30	38.5	27	34.6	4	5.1
	T (21)	3	14.3	7	33.3	11	52.4	0	0.0
	B (59)	22	37.2	22	37.2	10	16.9	5	8.5
	M (15)	1	6.7	5	33.3	7	46.7	2	13.3
	Totals (173)	43	24.9	64	37.0	55	31.8	11	6.4
Polar Coordinates	R (78)	17	21.8	23	29.5	35	44.9	3	3.8
	T (21)	5	23.8	8	38.1	6	28.6	2	9.5
	B (59)	21	35.6	25	42.3	9	15.3	4	6.8
	M (15)	1	6.7	5	33.3	7	46.7	2	13.3
	Totals (173)	44	25.4	61	35.3	57	32.9	11	6.4
Transformers:									
Theory	R (78)	37	47.4	28	35.9	13	16.7	0	0.0
	T (21)	15	71.4	6	28.6	0	0.0	0	0.0
	B (59)	34	57.6	19	32.2	6	10.1	0	0.0
	M (15)	4	26.7	10	66.7	1	6.7	0	0.0
	Totals (173)	90	52.0	63	36.4	20	11.6	0	0.0

TABLE 11--Continued

Units		Taught in Depth No.	Taught in Depth %	Empha-sized No.	Empha-sized %	Discussed Briefly No.	Discussed Briefly %	Not Taught No.	Not Taught %
Turns Ratio	R (78)	32	41.0	30	38.5	16	20.5	0	0.0
	T (21)	10	47.6	7	33.3	4	19.0	0	0.0
	B (59)	22	37.2	29	49.2	8	13.6	0	0.0
	M (15)	4	26.7	8	53.3	3	20.0	0	0.0
	Totals (173)	68	39.3	74	42.8	31	17.9	0	0.0
Impedance Matching	R (78)	33	42.3	31	39.7	14	17.9	0	0.0
	T (21)	12	57.1	8	38.1	1	4.8	0	0.0
	B (59)	39	66.1	16	27.1	4	6.8	0	0.0
	M (15)	5	33.3	7	46.7	3	20.0	0	0.0
	Totals (173)	89	51.4	62	35.8	22	12.7	0	0.0
Transformer Losses and Ratios	R (78)	16	20.5	36	46.2	26	33.3	0	0.0
	T (21)	8	38.1	8	38.1	4	19.0	1	4.8
	B (59)	22	37.2	26	44.1	11	18.6	0	0.0
	M (15)	3	20.0	5	33.3	7	46.7	0	0.0
	Totals (173)	49	28.3	75	43.4	48	27.7	1	0.6
Types and Applications (General)	R (78)	18	23.1	37	47.4	23	29.5	0	0.0
	T (21)	6	28.6	8	38.1	6	28.6	1	4.8
	B (59)	18	30.5	26	44.1	15	25.4	0	0.0
	M (15)	1	6.7	7	46.7	6	40.0	1	6.7
	Totals (173)	43	24.9	78	45.1	50	28.9	2	1.2

TABLE 11--Continued

Units		Taught in Depth No.	Taught in Depth %	Emphasized No.	Emphasized %	Discussed Briefly No.	Discussed Briefly %	Not Taught No.	Not Taught %
Three-Phase (Delta and Wye Connections)	R (78)	24	30.8	19	24.4	30	38.5	5	6.4
	T (21)	7	33.3	7	33.3	6	28.6	1	4.8
	B (59)	15	25.4	27	45.8	17	28.8	0	0.0
	M (15)	1	6.7	7	46.7	5	33.3	2	13.3
	Totals (173)	47	27.2	60	34.7	58	33.5	8	4.6
Frequency Response	R (78)	19	24.4	42	53.8	14	17.9	3	3.8
	T (21)	11	52.4	6	28.6	3	14.3	1	4.8
	B (59)	33	55.9	19	32.2	5	8.5	2	3.4
	M (15)	4	26.7	5	33.3	5	33.3	1	6.7
	Totals (173)	67	38.7	72	41.6	27	15.6	7	4.0
TEST EQUIPMENT									
Meter and Generator Usage:									
Basic Meter Movements	R (78)	30	38.5	34	43.6	12	15.4	2	2.6
	T (21)	12	57.1	8	38.1	1	4.8	0	0.0
	B (59)	19	32.2	27	45.8	11	16.6	2	3.4
	M (15)	6	40.0	5	33.3	4	26.7	0	0.0
	Totals (173)	67	38.7	74	42.8	28	16.2	4	2.3
VTVM's	R (78)	31	39.7	35	44.9	11	14.1	1	1.3
	T (21)	15	71.4	5	23.8	1	4.8	0	0.0
	B (59)	26	44.1	29	49.2	4	6.8	0	0.0
	M (15)	6	40.0	6	40.0	3	20.0	0	0.0
	Totals (173)	78	45.1	75	43.4	19	11.0	1	0.6

TABLE 11--Continued

Units		Taught in Depth No.	Taught in Depth %	Emphasized No.	Emphasized %	Discussed Briefly No.	Discussed Briefly %	Not Taught No.	Not Taught %
Transistor Voltmeters	R (78)	24	30.8	38	48.7	16	20.5	0	0.0
	T (21)	11	52.4	8	38.1	2	9.5	0	0.0
	B (59)	25	42.3	27	45.8	6	10.1	1	1.7
	M (15)	3	20.0	7	46.7	5	33.3	0	0.0
	Totals (173)	63	36.4	80	46.2	29	16.8	1	0.6
Multimeters	R (78)	32	41.0	30	38.5	15	19.2	1	1.3
	T (21)	12	57.1	9	42.9	0	0.0	0	0.0
	B (59)	17	28.8	34	57.6	8	13.6	0	0.0
	M (15)	4	26.7	6	40.0	5	33.3	0	0.0
	Totals (173)	65	37.6	79	45.7	28	16.2	1	0.6
Ohmmeters	R (78)	25	32.1	37	47.4	15	19.2	1	1.3
	T (21)	13	61.9	7	33.3	1	4.8	0	0.0
	B (59)	14	23.7	37	62.7	6	10.1	2	3.4
	M (15)	3	20.0	6	40.0	5	33.3	1	6.7
	Totals (173)	55	31.8	87	50.3	27	15.6	4	2.3
Storage Oscil-loscopes	R (78)	18	23.1	27	34.6	30	38.5	3	3.8
	T (21)	6	28.6	10	47.6	4	19.0	1	4.8
	B (59)	12	20.3	29	49.2	16	27.1	2	3.4
	M (15)	3	20.0	6	40.0	6	40.0	0	0.0
	Totals (173)	39	22.5	72	41.6	56	32.4	6	3.5

TABLE 11--Continued

Units		Taught in Depth No.	Taught in Depth %	Empha-sized No.	Empha-sized %	Discussed Briefly No.	Discussed Briefly %	Not Taught No.	Not Taught %
Laboratory Oscil-loscopes	R (78)	36	46.2	32	41.0	8	10.3	2	2.6
	T (21)	6	28.6	11	52.4	3	14.3	1	4.8
	B (59)	25	42.3	27	45.8	7	11.9	0	0.0
	M (15)	5	33.3	7	46.7	3	20.0	0	0.0
	Totals (173)	72	41.6	77	44.5	21	12.1	3	1.7
Wavemeters	R (78)	6	7.7	27	34.6	35	44.9	10	12.8
	T (21)	7	33.3	7	33.3	6	40.0	1	6.7
	B (59)	10	16.9	29	49.2	20	33.9	0	0.0
	M (15)	0	0.0	5	33.3	9	60.0	1	6.7
	Totals (173)	23	13.3	68	39.3	70	40.5	12	6.9
Impedance Bridge	R (78)	11	14.1	34	43.6	31	39.7	2	2.6
	T (21)	8	38.1	11	52.4	2	9.5	0	0.0
	B (59)	18	30.5	34	57.6	7	11.9	0	0.0
	M (15)	1	6.7	7	46.7	7	46.7	0	0.0
	Totals (173)	38	22.0	86	49.7	47	27.2	2	1.2
A-C Bridge	R (78)	13	16.7	25	32.1	38	48.7	2	2.6
	T (21)	8	38.1	9	42.9	4	19.0	0	0.0
	B (59)	11	18.6	35	59.3	13	22.0	0	0.0
	M (15)	0	0.0	8	53.3	7	46.7	0	0.0
	Totals (173)	32	18.5	77	44.5	62	35.8	2	1.2

TABLE 11--Continued

Units		Taught in Depth No.	Taught in Depth %	Empha-sized No.	Empha-sized %	Discussed Briefly No.	Discussed Briefly %	Not Taught No.	Not Taught %
Thermocouple Meter	R (78)	12	15.4	22	28.2	37	47.4	7	9.0
	T (21)	3	14.3	9	42.9	9	42.9	0	0.0
	B (59)	8	13.6	27	45.8	23	39.0	1	1.7
	M (15)	0	0.0	5	33.3	9	60.0	1	6.7
	Totals (173)	23	13.3	63	36.4	78	45.1	9	5.2
Wattmeter	R (78)	12	15.4	22	28.2	37	47.4	7	9.0
	T (21)	7	33.3	8	38.1	6	28.6	0	0.0
	B (59)	5	8.5	29	49.2	25	42.3	0	0.0
	M (15)	3	20.0	3	20.0	8	53.3	1	6.7
	Totals (173)	27	15.6	62	35.8	76	43.9	8	4.6
Tube Testers	R (78)	11	14.1	16	20.5	39	50.0	12	15.4
	T (21)	4	19.0	8	38.1	8	38.1	1	4.8
	B (59)	5	8.5	21	35.6	28	47.5	5	8.5
	M (15)	0	0.0	1	6.7	10	66.7	4	26.7
	Totals (173)	20	11.6	46	26.6	85	49.1	22	12.7
Transistor Analyzers	R (78)	22	29.2	29	37.2	22	29.2	5	6.4
	T (21)	9	42.9	7	33.3	4	19.0	1	4.8
	B (59)	22	37.2	29	49.2	7	11.9	1	1.7
	M (15)	0	0.0	7	46.7	7	46.7	1	6.7
	Totals (173)	53	30.6	72	41.6	40	23.1	8	4.6

TABLE 11--Continued

Units		Taught in Depth No.	Taught in Depth %	Empha-sized No.	Empha-sized %	Discussed Briefly No.	Discussed Briefly %	Not Taught No.	Not Taught %
Transistor Curve Tracers	R (78)	16	20.5	22	28.2	33	42.3	7	9.0
	T (21)	8	38.1	4	19.0	8	38.1	1	4.8
	B (59)	14	23.7	25	42.3	18	30.5	2	3.4
	M (15)	1	6.7	3	20.0	9	60.0	2	13.3
	Totals (173)	39	22.5	54	31.2	68	39.3	12	6.9
X-Y Plotters	R (78)	6	7.7	26	33.3	40	51.3	6	7.7
	T (21)	4	19.0	6	28.6	10	47.6	1	4.8
	B (59)	8	13.6	19	32.2	27	45.8	5	8.5
	M (15)	1	6.7	5	33.3	5	33.3	4	26.7
	Totals (173)	19	11.0	56	32.4	82	47.4	16	9.2
Capacitor Testers	R (78)	12	15.4	27	34.6	36	46.2	3	3.8
	T (21)	4	19.0	10	47.6	7	33.3	0	0.0
	B (59)	8	13.6	22	37.2	27	45.8	2	3.4
	M (15)	0	0.0	4	26.7	10	66.7	1	6.7
	Totals (173)	24	13.9	63	36.4	80	46.2	6	3.5
Q Meter	R (78)	4	5.1	23	29.5	43	55.1	8	10.3
	T (21)	2	9.5	8	38.1	9	42.9	2	9.5
	B (59)	4	6.8	19	32.2	30	50.8	6	10.1
	M (15)	0	0.0	4	26.7	10	66.7	1	6.7
	Totals (173)	10	5.8	54	31.2	92	53.2	17	9.8

TABLE 11--Continued

Units		Taught in Depth No.	Taught in Depth %	Emphasized No.	Emphasized %	Discussed Briefly No.	Discussed Briefly %	Not Taught No.	Not Taught %
Frequency Meter	R (78)	10	12.8	24	30.8	37	47.4	7	9.0
	T (21)	9	42.9	7	33.3	4	19.0	1	4.8
	B (59)	15	25.4	25	42.3	17	28.8	2	3.4
	M (15)	1	6.7	6	40.0	7	46.7	1	6.7
	Totals (173)	35	20.2	62	35.8	65	37.6	11	6.4
Sine-Wave Generators	R (78)	13	16.7	31	39.7	30	38.5	4	5.1
	T (21)	5	23.8	9	42.9	7	33.3	0	0.0
	B (59)	10	16.9	30	50.8	15	25.4	4	6.8
	M (15)	0	0.0	9	60.0	6	40.0	0	0.0
	Totals (173)	28	16.2	79	45.7	58	33.5	8	4.6
Signal Generators (a-f and r-f)	R (78)	14	17.9	36	46.2	26	33.3	2	2.6
	T (21)	7	33.3	11	52.4	3	14.3	0	0.0
	B (59)	18	30.5	30	50.8	10	16.9	1	1.7
	M (15)	2	13.3	7	46.7	6	40.0	0	0.0
	Totals (173)	41	23.7	84	48.6	45	26.0	3	1.7
Pulse Generator	R (78)	16	20.5	29	37.2	28	35.9	5	6.4
	T (21)	6	28.6	7	33.3	8	38.1	0	0.0
	B (59)	18	30.5	26	44.1	14	23.7	1	1.7
	M (15)	2	13.3	4	26.7	9	60.0	0	0.0
	Totals (173)	42	24.3	66	38.2	59	34.1	6	3.5

TABLE 11--Continued

Units		Taught in Depth No.	Taught in Depth %	Emphasized No.	Emphasized %	Discussed Briefly No.	Discussed Briefly %	Not Taught No.	Not Taught %
Square Wave Generator	R (78)	11	14.1	31	39.7	33	42.3	3	3.8
	T (21)	6	28.6	5	23.8	10	47.6	0	0.0
	B (59)	13	22.0	32	54.2	12	20.3	2	3.4
	M (15)	2	13.3	4	26.7	9	60.0	0	0.0
	Totals (173)	32	18.5	72	41.6	64	37.0	5	2.9
Sweep Generator	R (78)	9	11.5	24	30.8	40	51.3	5	6.4
	T (21)	5	23.8	6	28.6	10	47.6	0	0.0
	B (59)	15	25.4	32	54.2	11	18.6	1	1.7
	M (15)	2	13.3	5	33.3	8	53.3	0	0.0
	Totals (173)	31	17.9	67	38.7	69	39.9	6	3.5
Linearity Generator	R (78)	5	6.4	21	26.9	40	51.3	12	15.4
	T (21)	3	14.3	7	33.3	10	47.6	1	4.8
	B (59)	9	15.3	27	45.8	21	35.6	2	3.4
	M (15)	1	6.7	4	26.7	9	60.0	1	6.7
	Totals (173)	18	10.4	59	34.1	80	46.2	16	9.2
Time Mark Generator	R (78)	5	6.4	20	25.6	42	53.8	11	14.1
	T (21)	2	9.5	5	23.8	13	61.9	1	4.8
	B (59)	11	18.6	26	44.1	18	30.5	4	6.8
	M (15)	1	6.7	1	6.7	11	73.3	2	13.3
	Totals (173)	19	11.0	52	30.1	84	48.6	18	10.4

TABLE 11--Continued

Units		Taught in Depth		Empha-sized		Discussed Briefly		Not Taught	
		No.	%	No.	%	No.	%	No.	%
Time Domain Reflectometer	R (78)	4	5.1	15	19.2	38	48.7	21	26.9
	T (21)	3	14.3	5	23.8	9	42.9	4	19.0
	B (59)	7	11.9	24	40.7	21	35.6	7	11.9
	M (15)	1	6.7	2	13.3	8	53.3	4	26.7
	Totals (173)	15	8.7	46	26.6	76	43.9	36	20.8
Color Bar Generator	R (78)	2	2.6	12	15.4	46	59.0	18	23.1
	T (21)	4	19.0	6	28.6	5	23.8	6	28.6
	B (59)	14	23.7	30	50.8	14	23.7	1	1.7
	M (15)	1	6.7	2	13.3	9	60.0	3	20.0
	Totals (173)	21	12.1	50	28.9	74	42.8	28	16.2
Stroboscope	R (78)	4	5.1	18	23.1	43	55.1	13	16.7
	T (21)	3	14.3	5	23.8	8	38.1	5	23.8
	B (59)	4	6.8	15	25.4	35	59.3	5	8.5
	M (15)	0	0.0	4	26.7	9	60.0	2	13.3
	Totals (173)	11	6.4	42	24.3	95	54.9	25	14.5
Digital Counters	R (78)	23	29.5	37	47.4	17	21.8	1	1.3
	T (21)	7	33.3	6	28.6	7	33.3	1	4.8
	B (59)	22	37.2	22	37.2	12	20.3	3	5.1
	M (15)	2	13.3	8	53.3	5	33.3	0	0.0
	Totals (173)	54	31.2	73	42.2	41	23.7	5	2.9

TABLE 11--Continued

Units		Taught in Depth No.	Taught in Depth %	Empha-sized No.	Empha-sized %	Discussed Briefly No.	Discussed Briefly %	Not Taught No.	Not Taught %
Digital Voltmeters	R (78)	21	26.9	35	44.9	19	24.4	3	3.8
	T (21)	7	33.3	5	23.8	8	38.1	1	4.8
	B (59)	21	35.6	18	30.5	18	30.5	2	3.4
	M (15)	3	20.0	6	40.0	5	33.3	1	6.7
	Totals (173)	52	30.1	64	37.0	50	28.9	7	4.0
Nuclear Instruments	R (78)	6	7.7	18	23.1	38	48.7	16	20.5
	T (21)	2	9.5	6	28.6	6	28.6	7	33.3
	B (59)	15	25.4	10	16.9	24	40.7	10	16.9
	M (15)	2	13.3	2	13.3	9	60.0	2	13.3
	Totals (173)	25	14.5	36	20.8	77	44.5	35	20.2
INDUCTANCE AND CAPACITANCE									
Inductance:									
Self-Inductance	R (78)	30	38.5	33	42.3	15	19.2	0	0.0
	T (21)	15	71.4	5	23.8	1	4.8	0	0.0
	B (59)	22	37.2	27	45.8	9	15.3	1	1.7
	M (15)	7	46.7	5	33.3	3	20.0	0	0.0
	Totals (173)	74	42.8	70	40.5	28	16.2	1	0.6
Mutual Inductance	R (78)	30	38.5	31	39.7	17	21.8	0	0.0
	T (21)	15	71.4	5	23.8	1	4.8	0	0.0
	B (59)	22	37.2	27	45.8	10	16.9	0	0.0
	M (15)	5	33.3	7	46.7	3	20.0	0	0.0
	Totals (173)	72	41.6	70	40.5	31	17.9	0	0.0

TABLE 11--Continued

Units		Taught in Depth No.	Taught in Depth %	Emphasized No.	Emphasized %	Discussed Briefly No.	Discussed Briefly %	Not Taught No.	Not Taught %
Series and Parallel	R (78)	32	41.0	31	39.7	14	17.9	1	1.3
	T (21)	13	61.9	8	38.1	0	0.0	0	0.0
	B (59)	25	42.3	26	44.1	8	13.6	0	0.0
	M (15)	6	40.0	5	33.3	4	26.7	0	0.0
	Totals (173)	76	43.9	70	40.5	26	15.0	1	0.6
Lenz's Law	R (78)	22	28.2	31	39.7	22	28.2	3	3.8
	T (21)	6	28.6	12	57.1	3	14.3	0	0.0
	B (59)	13	22.0	28	47.5	15	25.4	3	5.1
	M (15)	3	20.0	5	33.3	6	40.0	1	6.7
	Totals (173)	44	25.4	76	43.9	46	26.6	7	4.0
Inductive Reactance	R (78)	30	38.5	35	44.9	13	16.7	0	0.0
	T (21)	12	57.1	9	42.9	0	0.0	0	0.0
	B (59)	31	52.5	24	40.7	4	6.8	0	0.0
	M (15)	5	33.3	7	46.7	3	20.0	0	0.0
	Totals (173)	78	45.1	75	43.4	20	11.6	0	0.0
Instantaneous Current Analysis	R (78)	19	24.4	35	44.9	22	28.2	2	2.6
	T (21)	6	28.6	13	61.9	1	4.8	1	4.8
	B (59)	19	32.2	26	44.1	13	22.0	1	1.7
	M (15)	3	20.0	4	26.7	8	53.3	0	0.0
	Totals (173)	47	27.2	78	45.1	44	25.4	4	2.3

TABLE 11--Continued

Units		Taught in Depth No.	Taught in Depth %	Emphasized No.	Emphasized %	Discussed Briefly No.	Discussed Briefly %	Not Taught No.	Not Taught %
A-F and R-F Chokes	R (78)	15	19.2	28	35.9	34	43.6	1	1.3
	T (21)	6	28.6	11	52.4	4	19.0	0	0.0
	B (59)	18	30.5	32	54.2	8	13.6	1	1.7
	M (15)	3	20.0	5	33.3	7	46.7	0	0.0
	Totals (173)	42	24.3	76	43.9	53	30.6	2	1.2
Q of a Coil	R (78)	15	19.2	37	47.4	24	30.8	2	2.6
	T (21)	7	33.3	10	47.6	2	9.5	2	9.5
	B (59)	18	30.5	33	55.9	8	13.6	0	0.0
	M (15)	4	26.7	4	26.7	7	46.7	0	0.0
	Totals (173)	44	25.4	84	48.6	41	23.7	4	2.3
Capacitance: Theory of Operation	R (78)	42	53.8	23	29.5	13	16.7	0	0.0
	T (21)	18	85.7	3	14.3	0	0.0	0	0.0
	B (59)	31	52.5	24	40.7	4	6.8	0	0.0
	M (15)	9	60.0	3	20.0	3	20.0	0	0.0
	Totals (173)	100	57.8	53	30.6	20	11.6	0	0.0
Capacitor Types and Rating	R (78)	30	38.5	36	46.2	12	15.4	0	0.0
	T (21)	10	47.6	9	42.9	2	9.5	0	0.0
	B (59)	17	28.8	35	59.3	7	11.9	0	0.0
	M (15)	6	40.0	4	26.7	5	33.3	0	0.0
	Totals (173)	63	36.4	84	48.6	26	15.0	0	0.0

TABLE 11--Continued

Units		Taught in Depth No.	Taught in Depth %	Emphasized No.	Emphasized %	Discussed Briefly No.	Discussed Briefly %	Not Taught No.	Not Taught %
Effects in D-C Circuits	R (78)	32	41.0	32	41.0	14	17.9	0	0.0
	T (21)	14	66.7	7	33.3	0	0.0	0	0.0
	B (59)	22	37.2	34	57.6	3	5.1	0	0.0
	M (15)	7	46.7	3	20.0	5	33.3	0	0.0
	Totals (173)	75	43.4	76	43.9	22	12.7	0	0.0
R-C Circuits and Time Constants	R (78)	43	55.1	25	32.1	10	12.8	0	0.0
	T (21)	10	47.6	11	52.4	0	0.0	0	0.0
	B (59)	31	52.5	26	44.1	2	3.4	0	0.0
	M (15)	6	40.0	5	33.3	4	26.7	0	0.0
	Totals (173)	90	52.0	67	38.7	16	9.2	0	0.0
Capacitive Reactance	R (78)	31	39.7	37	47.4	10	12.8	0	0.0
	T (21)	11	52.4	8	38.1	1	4.8	1	4.8
	B (59)	30	50.8	24	40.7	5	8.5	0	0.0
	M (15)	6	40.0	5	33.3	4	26.7	0	0.0
	Totals (173)	78	45.1	74	42.8	20	11.6	1	0.6
Bypass Capacitor Effect	R (78)	23	29.5	37	47.4	18	23.1	0	0.0
	T (21)	9	42.9	8	38.1	2	9.5	2	9.5
	B (59)	19	32.2	31	52.5	9	15.3	0	0.0
	M (15)	4	26.7	4	26.7	7	46.7	0	0.0
	Totals (173)	55	31.8	80	46.2	36	20.8	2	1.2

TABLE 11--Continued

Units		Taught in Depth No.	Taught in Depth %	Emphasized No.	Emphasized %	Discussed Briefly No.	Discussed Briefly %	Not Taught No.	Not Taught %
R-L-C Circuits: Series R-L-C Circuits	R (78)	39	50.0	25	32.1	14	17.9	0	0.0
	T (21)	9	42.9	10	47.6	2	9.5	0	0.0
	B (59)	33	55.9	24	40.7	2	3.4	0	0.0
	M (15)	5	33.3	5	33.3	5	33.3	0	0.0
	Totals (173)	86	49.7	64	37.0	23	13.3	0	0.0
Parallel R-L-C Circuits	R (78)	39	50.0	25	32.1	14	17.9	0	0.0
	T (21)	9	42.9	10	47.6	2	9.5	0	0.0
	B (59)	34	57.6	23	39.0	2	3.4	0	0.0
	M (15)	5	33.3	5	33.3	5	33.3	0	0.0
	Totals (173)	87	50.3	63	36.4	23	13.3	0	0.0
Phase Relationships and Effects of Varying Circuit Properties	R (78)	24	30.8	28	35.9	16	20.5	10	12.8
	T (21)	5	23.8	7	33.3	5	23.8	4	19.0
	B (59)	26	44.1	15	25.4	8	13.6	10	16.9
	M (15)	3	20.0	6	40.0	3	20.0	3	20.0
	Totals (173)	58	33.5	56	32.4	32	18.5	27	15.6
Parallel, Series Resonant Circuits: Resonant Circuit "Q"	R (78)	24	30.8	29	37.2	20	25.6	5	6.4
	T (21)	6	28.6	11	52.4	3	14.3	1	4.8
	B (59)	22	37.2	30	50.8	6	10.1	1	1.7
	M (15)	1	6.7	6	40.0	7	46.7	1	6.7
	Totals (173)	53	30.6	76	43.9	36	20.8	8	4.6

TABLE 11--Continued

Units		Taught in Depth No.	Taught in Depth %	Emphasized No.	Emphasized %	Discussed Briefly No.	Discussed Briefly %	Not Taught No.	Not Taught %
Analysis of Series and Parallel Resonant Circuits	R (78)	24	30.8	29	37.2	21	26.9	4	5.1
	T (21)	9	42.9	9	42.9	2	9.5	1	4.8
	B (59)	27	45.8	25	42.3	6	10.1	1	1.7
	M (15)	3	20.0	6	40.0	6	40.0	0	0.0
	Totals (173)	63	36.4	69	39.9	35	20.2	6	3.5
Resonant Circuit Bandwidth	R (78)	22	28.2	28	35.9	24	30.8	4	5.1
	T (21)	5	23.8	13	61.9	3	14.3	0	0.0
	B (59)	21	35.6	28	47.5	10	16.9	0	0.0
	M (15)	3	20.0	6	40.0	5	33.3	1	6.7
	Totals (173)	51	29.5	75	43.4	42	24.3	5	2.9
Applications of Resonant Circuits	R (78)	22	28.2	33	42.3	21	26.9	2	2.6
	T (21)	5	23.8	10	47.6	6	28.6	0	0.0
	B (59)	20	33.9	33	55.9	6	10.1	0	0.0
	M (15)	4	26.7	2	13.3	8	53.3	1	6.7
	Totals (173)	51	29.5	78	45.1	41	23.7	3	1.7
Frequency Response Curves	R (78)	18	23.1	36	46.2	20	25.6	4	5.1
	T (21)	8	38.1	9	42.9	3	14.3	1	4.8
	B (59)	21	35.6	30	50.8	8	13.6	0	0.0
	M (15)	2	13.3	3	20.0	10	66.7	0	0.0
	Totals (173)	49	28.3	78	45.1	41	23.7	5	2.9

TABLE 11--Continued

Units		Taught in Depth No.	Taught in Depth %	Emphasized No.	Emphasized %	Discussed Briefly No.	Discussed Briefly %	Not Taught No.	Not Taught %
Resonant Filters	R (78)	20	25.6	27	34.6	24	30.8	7	9.0
	T (21)	4	19.0	10	47.6	7	33.3	0	0.0
	B (59)	19	32.2	26	44.1	14	23.7	0	0.0
	M (15)	1	6.7	3	20.0	10	66.7	1	6.7
	Totals (173)	44	25.4	66	38.2	55	31.8	8	4.6
VACUUM TUBES									
Fundamentals:									
Early Development and Use	R (78)	5	6.4	13	16.7	51	65.4	9	11.5
	T (21)	2	9.5	7	33.3	11	52.4	1	4.8
	B (59)	7	11.9	9	15.3	39	66.1	4	6.8
	M (15)	1	6.7	2	13.3	8	53.3	4	26.7
	Totals (173)	15	8.7	31	17.9	109	63.0	18	10.4
Emitter Materials	R (78)	4	5.1	13	16.7	46	59.0	15	19.2
	T (21)	1	4.8	9	42.9	10	47.6	1	4.8
	B (59)	5	8.5	17	28.8	33	55.9	4	6.8
	M (15)	0	0.0	2	13.3	11	73.3	2	13.3
	Totals (173)	10	5.8	41	23.7	100	57.8	22	12.7
Types of Envelopes and Bases	R (78)	5	6.4	10	12.8	46	59.0	17	21.8
	T (21)	0	0.0	10	47.6	9	42.9	2	9.5
	B (59)	3	5.1	11	18.6	41	69.5	4	6.8
	M (15)	0	0.0	0	0.0	11	73.3	4	26.7
	Totals (173)	8	4.6	31	17.9	107	61.8	27	15.6

TABLE 11--Continued

Units		Taught in Depth No.	Taught in Depth %	Emphasized No.	Emphasized %	Discussed Briefly No.	Discussed Briefly %	Not Taught No.	Not Taught %
Types of Emission	R (78)	5	6.4	15	19.2	47	60.3	11	14.1
	T (21)	0	0.0	10	47.6	10	47.6	1	4.8
	B (59)	8	13.6	17	28.8	30	50.8	4	6.8
	M (15)	1	6.7	1	6.7	10	66.7	3	20.0
	Totals (173)	14	8.1	43	24.9	97	56.1	19	11.0
Cathodes; Directly and Indirectly Heated	R (78)	5	6.4	16	20.5	47	60.3	10	12.8
	T (21)	1	4.8	10	47.6	9	42.9	1	4.8
	B (59)	9	15.3	15	25.4	32	54.2	3	5.1
	M (15)	0	0.0	1	6.7	12	80.0	2	13.3
	Totals (173)	15	8.7	42	24.3	100	57.8	16	9.2
Diodes:									
Characteristic Curves	R (78)	13	16.7	27	34.6	30	38.5	8	10.3
	T (21)	8	38.1	8	38.1	5	23.8	0	0.0
	B (59)	10	16.9	28	47.5	20	33.9	1	1.7
	M (15)	1	6.7	3	20.0	10	66.7	1	6.7
	Totals (173)	32	18.5	66	38.2	65	37.6	10	5.8
Rectification, Detection	R (78)	17	21.8	24	30.8	30	38.5	7	9.0
	T (21)	7	33.3	10	47.6	4	19.0	0	0.0
	B (59)	16	27.1	28	47.5	15	25.4	0	0.0
	M (15)	2	13.3	3	20.0	9	60.0	1	6.7
	Totals (173)	42	24.3	65	37.6	58	33.5	8	4.6

TABLE 11--Continued

Units		Taught in Depth No.	Taught in Depth %	Emphasized No.	Emphasized %	Discussed Briefly No.	Discussed Briefly %	Not Taught No.	Not Taught %
Triodes:									
Biasing Methods, Positive and Negative	R (78)	14	17.9	20	25.6	36	46.2	8	10.3
	T (21)	7	33.3	9	42.9	4	19.0	1	4.8
	B (59)	22	37.2	21	35.6	16	27.1	0	0.0
	M (15)	1	6.7	4	26.7	8	53.3	2	13.3
	Totals (173)	44	25.4	54	31.2	64	37.0	11	6.4
Load Lines	R (78)	11	14.1	19	24.4	37	47.4	11	14.1
	T (21)	4	19.0	11	52.4	6	28.6	0	0.0
	B (59)	14	23.7	26	44.1	19	32.2	0	0.0
	M (15)	0	0.0	3	20.0	10	66.7	2	13.3
	Totals (173)	29	16.8	59	34.1	72	41.6	13	7.5
Saturation	R (78)	7	9.0	19	24.4	42	53.8	10	12.8
	T (21)	5	23.8	8	38.1	7	33.3	1	4.8
	B (59)	11	18.6	26	44.1	22	37.2	0	0.0
	M (15)	0	0.0	2	13.3	10	66.7	3	20.0
	Totals (173)	23	13.3	55	31.8	81	46.8	14	8.1
Interelectrode Capacitance	R (78)	5	6.4	20	25.6	40	51.3	13	16.7
	T (21)	4	19.0	9	42.9	6	28.6	2	9.5
	B (59)	12	20.3	22	37.2	25	42.3	0	0.0
	M (15)	0	0.0	4	26.7	8	53.3	3	20.0
	Totals (173)	21	12.1	55	31.8	79	45.7	18	10.4

TABLE 11--Continued

Units		Taught in Depth No.	Taught in Depth %	Emphasized No.	Emphasized %	Discussed Briefly No.	Discussed Briefly %	Not Taught No.	Not Taught %
Transconductance, Plate Resistance, Amplification Factor	R (78)	7	9.0	24	30.8	35	44.9	12	15.4
	T (21)	3	14.3	10	47.6	7	33.3	1	4.8
	B (59)	15	25.4	29	49.2	15	25.4	0	0.0
	M (15)	0	0.0	5	33.3	7	46.7	3	20.0
	Totals (173)	25	14.5	68	39.3	64	37.0	16	9.2
Static and Dynamic Characteristic Curves	R (78)	7	9.0	23	29.5	36	46.2	12	15.4
	T (21)	2	9.5	8	38.1	10	47.6	1	4.8
	B (59)	11	18.6	24	40.7	21	35.6	3	5.1
	M (15)	0	0.0	3	20.0	10	66.7	2	13.3
	Totals (173)	20	11.6	58	33.5	77	44.5	18	10.4
Transfer Curves	R (78)	6	7.7	18	23.1	41	52.6	13	16.7
	T (21)	2	9.5	10	47.6	8	38.1	1	4.8
	B (59)	9	15.3	26	44.1	23	39.0	1	1.7
	M (15)	0	0.0	2	13.3	10	66.7	3	20.0
	Totals (173)	17	9.8	56	32.4	82	47.4	18	10.4
Voltage Amplification	R (78)	9	11.5	24	30.8	36	46.2	9	11.5
	T (21)	2	9.5	13	61.9	6	28.6	0	0.0
	B (59)	18	30.5	25	42.3	16	27.1	0	0.0
	M (15)	1	6.7	3	20.0	9	60.0	2	13.3
	Totals (173)	30	17.2	65	37.6	67	38.6	11	6.4

TABLE 11--Continued

Units		Taught in Depth No.	Taught in Depth %	Emphasized No.	Emphasized %	Discussed Briefly No.	Discussed Briefly %	Not Taught No.	Not Taught %
Equivalent Circuits	R (78)	10	12.8	21	26.9	38	48.7	9	11.5
	T (21)	3	14.3	12	57.1	5	23.8	1	4.8
	B (59)	13	22.0	26	44.1	18	30.5	2	3.4
	M (15)	0	0.0	5	33.3	8	53.3	2	13.3
	Totals (173)	26	15.0	64	37.0	69	39.9	14	8.1
Tetrodes:									
Interelectrode Capacitance	R (78)	5	6.4	18	23.1	43	55.1	12	15.4
	T (21)	3	14.3	10	47.6	8	38.1	0	0.0
	B (59)	11	18.6	26	44.1	22	37.2	0	0.0
	M (15)	0	0.0	3	20.0	9	60.0	3	20.0
	Totals (173)	19	11.0	57	32.9	82	47.4	15	8.7
Effect of Screen Grid	R (78)	5	6.4	22	28.2	41	52.6	10	12.8
	T (21)	3	14.3	11	52.4	7	33.3	0	0.0
	B (59)	11	18.6	32	54.2	16	27.1	0	0.0
	M (15)	0	0.0	3	20.0	9	60.0	3	20.0
	Totals (173)	19	11.0	68	39.3	73	42.2	13	7.5
Effects of Secondary Emission	R (78)	5	6.4	20	25.6	41	52.6	12	15.4
	T (21)	2	9.5	12	57.1	7	33.3	0	0.0
	B (59)	9	15.3	29	49.2	20	33.8	1	1.7
	M (15)	0	0.0	3	20.0	9	60.0	3	20.0
	Totals (173)	16	9.2	64	37.0	77	44.5	16	9.2

TABLE 11--Continued

Units		Taught in Depth No.	Taught in Depth %	Emphasized No.	Emphasized %	Discussed Briefly No.	Discussed Briefly %	Not Taught No.	Not Taught %
Plate and Screen Characteristic Curves	R (78)	4	5.1	19	24.4	41	52.6	14	17.9
	T (21)	2	9.5	9	42.9	9	42.9	1	4.8
	B (59)	11	18.6	29	49.2	19	32.2	0	0.0
	M (15)	0	0.0	2	13.3	11	73.3	2	13.3
	Totals (173)	17	9.8	59	34.1	80	46.2	17	9.8
Pentodes:									
Effects of Suppressor Grid	R (78)	5	6.4	17	21.8	45	57.7	11	14.1
	T (21)	2	9.5	12	57.1	7	33.3	0	0.0
	B (59)	10	16.9	29	49.2	19	32.2	1	1.7
	M (15)	1	6.7	2	13.3	9	60.0	3	20.0
	Totals (173)	18	10.4	60	34.7	80	46.2	15	8.7
Plate and Dynamic Characteristic Curves	R (78)	5	6.4	21	26.9	37	47.4	15	19.2
	T (21)	2	9.5	10	47.6	9	42.9	0	0.0
	B (59)	10	16.9	31	52.5	17	28.8	1	1.7
	M (15)	0	0.0	2	13.3	10	66.7	3	20.0
	Totals (173)	17	9.8	64	37.0	73	42.2	19	11.0
Tube Parameters	R (78)	3	3.8	22	28.2	40	51.3	13	16.7
	T (21)	1	4.8	7	33.3	13	61.9	0	0.0
	B (59)	8	13.6	30	50.8	19	32.2	2	3.4
	M (15)	0	0.0	2	13.3	10	66.7	3	20.0
	Totals (173)	12	6.9	61	35.3	82	47.4	18	10.4

TABLE 11--Continued

Units		Taught in Depth No.	Taught in Depth %	Emphasized No.	Emphasized %	Discussed Briefly No.	Discussed Briefly %	Not Taught No.	Not Taught %
Sharp and Remote Cut-off Characteristics	R (78)	6	7.7	19	24.4	40	51.3	13	16.7
	T (21)	2	9.5	10	47.6	9	42.9	0	0.0
	B (59)	8	13.6	29	49.2	22	37.2	0	0.0
	M (15)	1	6.7	2	13.3	9	60.0	3	20.0
	Totals (173)	17	9.8	60	34.7	80	46.2	16	9.2
Beam Power Tubes	R (78)	4	5.1	21	26.9	41	52.6	12	15.4
	T (21)	3	14.3	9	42.9	8	38.1	1	4.8
	B (59)	9	15.3	28	47.5	22	37.2	0	0.0
	M (15)	0	0.0	3	20.0	9	60.0	3	20.0
	Totals (173)	16	9.2	61	35.3	80	46.2	16	9.2
Multigrid Tubes: Pentagrid Converters	R (78)	5	6.4	14	17.9	44	56.4	15	19.2
	T (21)	3	14.3	8	38.1	8	38.1	2	9.5
	B (59)	6	10.1	27	45.8	24	40.7	2	3.4
	M (15)	1	6.7	2	13.3	8	53.3	4	26.7
	Totals (173)	15	8.7	51	29.5	84	48.6	23	13.3
Pentagrid Mixers	R (78)	5	6.4	14	17.9	44	56.4	15	19.2
	T (21)	2	9.5	7	33.3	10	47.6	2	9.5
	B (59)	7	11.9	26	44.1	24	40.7	2	3.4
	M (15)	1	6.7	2	13.3	7	46.7	5	33.3
	Totals (173)	15	8.7	49	28.3	85	49.1	24	13.9

TABLE 11--Continued

Units		Taught in Depth No.	Taught in Depth %	Emphasized No.	Emphasized %	Discussed Briefly No.	Discussed Briefly %	Not Taught No.	Not Taught %
Special Application Tubes:									
Multisection Tubes	R (78)	4	5.1	14	17.9	43	55.1	17	21.8
	T (21)	2	9.5	7	33.3	10	47.6	2	9.5
	B (59)	6	10.1	23	39.0	27	45.8	3	5.1
	M (15)	0	0.0	2	13.3	9	60.0	4	26.7
	Totals (173)	12	6.9	46	26.6	89	51.4	26	15.0
Subminiature Tubes	R (78)	5	6.4	12	15.4	44	56.4	17	21.8
	T (21)	2	9.5	7	33.3	11	52.4	1	4.8
	B (59)	7	11.9	21	35.6	28	47.5	3	5.1
	M (15)	0	0.0	2	13.3	8	53.3	5	33.3
	Totals (173)	14	8.1	42	24.3	91	52.6	26	15.0
Gas-Filled Regulators	R (78)	4	5.1	19	24.4	41	52.6	14	17.9
	T (21)	4	19.0	9	42.9	7	33.3	1	4.8
	B (59)	5	8.5	23	39.0	28	47.5	3	5.1
	M (15)	0	0.0	4	26.7	7	46.7	4	26.7
	Totals (173)	13	7.5	55	31.8	83	48.0	22	12.7
Thyratron Tubes	R (78)	7	9.0	20	25.6	42	53.8	9	11.5
	T (21)	2	9.5	10	47.6	7	33.3	2	9.5
	B (59)	5	8.5	26	44.1	26	44.1	2	3.4
	M (15)	1	6.7	2	13.3	10	66.7	2	13.3
	Totals (173)	15	8.7	58	33.5	85	49.1	15	8.7

TABLE 11--Continued

Units		Taught in Depth		Empha-sized		Discussed Briefly		Not Taught	
		No.	%	No.	%	No.	%	No.	%
Ignitrons	R (78)	8	10.3	13	16.7	42	53.8	15	19.2
	T (21)	1	4.8	8	38.1	10	47.6	2	9.5
	B (59)	2	3.4	25	42.3	29	49.2	3	5.1
	M (15)	1	6.7	1	6.7	10	66.7	3	20.0
	Totals (173)	12	6.9	47	27.2	91	52.6	23	13.3
Phototubes	R (78)	9	11.5	21	26.9	40	51.3	8	10.3
	T (21)	2	9.5	10	47.6	7	33.3	2	9.5
	B (59)	6	10.1	22	37.2	29	49.2	2	3.4
	M (15)	1	6.7	4	26.7	7	46.7	3	20.0
	Totals (173)	18	10.4	57	32.9	83	48.0	15	8.7
Photo-Multiplier Tubes	R (78)	10	12.8	17	21.8	42	53.8	9	11.5
	T (21)	2	9.5	10	47.6	7	33.3	2	9.5
	B (59)	6	10.1	23	39.0	25	42.3	5	8.5
	M (15)	1	6.7	3	20.0	9	60.0	2	13.3
	Totals (173)	19	11.0	53	30.6	83	48.0	18	10.4
Electron-Ray Indicators	R (78)	5	6.4	15	19.2	44	56.4	14	17.9
	T (21)	2	9.5	9	42.9	8	38.1	2	9.5
	B (59)	5	8.5	22	37.2	28	47.5	4	6.8
	M (15)	1	6.7	5	33.3	8	53.3	1	6.7
	Totals (173)	13	7.5	51	29.5	88	50.9	21	12.1

TABLE 11--Continued

Units		Taught in Depth No.	Taught in Depth %	Emphasized No.	Emphasized %	Discussed Briefly No.	Discussed Briefly %	Not Taught No.	Not Taught %
Cathode-Ray Tubes	R (78)	14	17.9	25	32.1	33	42.3	6	7.7
	T (21)	4	19.0	9	42.9	6	28.6	2	9.5
	B (59)	19	32.2	24	40.7	14	23.7	2	3.4
	M (15)	3	20.0	7	46.7	4	26.7	1	6.7
	Totals (173)	40	23.1	65	37.6	57	32.9	11	6.4
High Frequency Tubes	R (78)	5	6.4	19	24.4	41	52.6	13	16.7
	T (21)	6	28.6	6	28.6	7	33.3	2	9.5
	B (59)	18	30.5	25	42.3	14	23.7	2	3.4
	M (15)	1	6.7	5	33.3	8	53.3	1	6.7
	Totals (173)	30	17.3	55	31.8	70	40.5	18	10.4
Klystrons	R (78)	8	10.3	18	23.1	36	46.2	16	20.5
	T (21)	5	23.8	9	42.9	6	28.6	1	4.8
	B (59)	21	35.6	24	40.7	12	20.3	2	3.4
	M (15)	2	13.3	5	33.3	6	40.0	2	13.3
	Totals (173)	36	20.8	56	32.4	60	34.7	21	12.1
SEMICONDUCTORS Fundamentals:									
Early Development and Usage	R (78)	13	16.7	28	35.9	30	38.5	7	9.0
	T (21)	4	19.0	7	33.3	9	42.9	1	4.8
	B (59)	11	18.6	21	35.6	26	44.1	1	1.7
	M (15)	2	13.3	3	20.0	7	46.7	3	20.0
	Totals (173)	30	17.3	59	34.1	72	41.6	12	6.9

TABLE 11--Continued

Units		Taught in Depth No.	Taught in Depth %	Empha-sized No.	Empha-sized %	Discussed Briefly No.	Discussed Briefly %	Not Taught No.	Not Taught %
Atomic Structure	R (78)	14	17.9	28	35.9	31	39.7	5	6.4
	T (21)	6	28.6	9	42.9	6	28.6	0	0.0
	B (59)	13	22.0	25	42.3	18	30.5	3	5.1
	M (15)	2	13.3	4	26.7	7	46.7	2	13.3
	Totals (173)	35	20.2	66	38.2	62	35.8	10	5.8
Crystal Structure	R (78)	15	19.2	28	35.9	31	39.7	4	5.1
	T (21)	7	33.3	8	38.1	6	28.6	0	0.0
	B (59)	12	20.3	26	44.1	20	33.9	1	1.7
	M (15)	3	20.0	6	40.0	4	26.7	2	13.3
	Totals (173)	37	21.4	68	39.3	61	35.3	7	4.0
Bonds	R (78)	14	17.9	29	37.2	30	38.5	5	6.4
	T (21)	6	28.6	8	38.1	7	33.3	0	0.0
	B (59)	10	16.9	25	42.3	24	40.7	0	0.0
	M (15)	2	13.3	5	33.3	6	40.0	2	13.3
	Totals (173)	32	18.5	67	38.7	67	38.7	7	4.0
Impurities	R (78)	15	19.2	26	33.3	33	42.3	4	5.1
	T (21)	4	19.0	8	38.1	9	42.9	0	0.0
	B (59)	10	16.9	25	42.3	24	40.7	0	0.0
	M (15)	2	13.3	5	33.3	7	46.7	1	6.7
	Totals (173)	31	17.9	64	37.0	73	42.2	5	2.9

TABLE 11--Continued

Units		Taught in Depth No.	Taught in Depth %	Emphasized No.	Emphasized %	Discussed Briefly No.	Discussed Briefly %	Not Taught No.	Not Taught %
Classification	R (78)	21	26.9	26	33.3	30	38.5	1	1.3
	T (21)	5	23.8	7	33.3	9	42.9	0	0.0
	B (59)	14	23.7	24	40.7	21	35.6	0	0.0
	M (15)	2	13.3	9	60.0	4	26.7	0	0.0
	Totals (173)	42	24.3	66	38.2	64	37.0	1	0.6
Electrons and Hole Charges	R (78)	19	24.4	29	37.2	28	35.9	2	2.6
	T (21)	8	38.1	6	28.6	7	33.3	0	0.0
	B (59)	18	30.5	26	44.1	15	25.4	0	0.0
	M (15)	2	13.3	7	46.7	5	33.3	1	6.7
	Totals (173)	47	27.2	68	39.3	55	31.8	3	1.7
Semiconductor Diodes:									
Color Code	R (78)	28	35.9	27	34.6	20	25.6	3	3.8
	T (21)	9	42.9	8	38.1	4	19.0	0	0.0
	B (59)	10	16.9	26	44.1	22	37.2	1	1.7
	M (15)	6	40.0	4	26.7	4	26.7	1	6.7
	Totals (173)	53	30.6	65	37.6	50	28.9	5	2.9
PN Junctions	R (78)	29	37.2	31	39.7	18	23.1	0	0.0
	T (21)	7	33.3	10	47.6	4	19.0	0	0.0
	B (59)	17	28.8	32	54.2	10	16.9	0	0.0
	M (15)	4	26.7	7	46.7	3	20.0	1	6.7
	Totals (173)	57	32.9	80	46.2	35	20.2	1	0.6

TABLE 11--Continued

Units		Taught in Depth No.	Taught in Depth %	Emphasized No.	Emphasized %	Discussed Briefly No.	Discussed Briefly %	Not Taught No.	Not Taught %
Forward and Reverse Bias	R (78)	35	44.9	32	41.0	11	14.1	0	0.0
	T (21)	6	28.6	12	57.1	3	14.3	0	0.0
	B (59)	27	45.8	27	45.8	5	8.5	0	0.0
	M (15)	5	33.3	7	46.7	3	20.0	0	0.0
	Totals (173)	73	42.2	78	45.1	22	12.7	0	0.0
Characteristic Curves	R (78)	35	44.9	30	38.5	13	16.7	0	0.0
	T (21)	5	23.8	12	57.1	3	14.3	1	4.8
	B (59)	20	33.9	28	47.5	11	18.6	0	0.0
	M (15)	3	20.0	7	46.7	5	33.3	0	0.0
	Totals (173)	63	36.4	77	44.5	32	18.5	1	0.6
Types of Diodes (Point-Contact, Tunnel, Zener, Photo, etc.)	R (78)	27	34.6	32	41.0	18	23.1	1	1.3
	T (21)	7	33.3	9	42.9	5	23.8	0	0.0
	B (59)	21	35.6	30	50.8	7	11.9	1	1.7
	M (15)	5	33.3	5	33.3	4	26.7	1	6.7
	Totals (173)	60	34.7	76	43.9	34	19.7	3	1.7
Silicon Controlled Rectifiers and Switches	R (78)	38	48.7	30	38.5	10	12.8	0	0.0
	T (21)	7	33.3	9	42.9	4	19.0	1	4.8
	B (59)	30	50.8	25	42.3	4	6.8	0	0.0
	M (15)	4	26.7	9	60.0	2	13.3	0	0.0
	Totals (173)	79	45.7	73	42.2	20	11.6	1	0.6

TABLE 11--Continued

Units		Taught in Depth No.	Taught in Depth %	Emphasized No.	Emphasized %	Discussed Briefly No.	Discussed Briefly %	Not Taught No.	Not Taught %
Variable-Capacitance Diodes	R (78)	24	30.8	30	38.5	22	28.2	2	2.6
	T (21)	7	33.3	10	47.6	4	19.0	0	0.0
	B (59)	23	39.0	27	45.8	9	15.3	0	0.0
	M (15)	3	20.0	9	60.0	3	20.0	0	0.0
	Totals (173)	57	32.9	76	43.9	38	22.0	2	1.2
Hall Generators	R (78)	13	16.7	30	38.5	29	37.2	6	7.7
	T (21)	3	14.3	9	42.9	9	42.9	0	0.0
	B (59)	14	23.7	28	47.5	13	22.0	4	6.8
	M (15)	3	20.0	4	26.7	8	53.3	0	0.0
	Totals (173)	33	19.1	71	41.0	59	34.1	10	5.8
TRANSISTORS Construction and Characteristics:									
Transistor Fabrication	R (78)	7	9.0	19	24.4	46	59.0	6	7.7
	T (21)	7	33.3	5	23.8	9	42.9	0	0.0
	B (59)	15	25.4	22	37.2	19	32.2	3	5.1
	M (15)	2	13.3	3	20.0	8	53.3	2	13.3
	Totals (173)	31	17.9	49	28.3	82	47.4	11	6.4
Configurations	R (78)	10	12.8	32	41.0	31	39.7	5	6.4
	T (21)	6	20.6	8	38.1	7	33.3	0	0.0
	B (59)	18	30.5	22	37.2	18	30.5	1	1.7
	M (15)	3	20.0	3	20.0	8	53.3	1	6.7
	Totals (173)	37	21.4	65	37.6	64	37.0	7	4.0

TABLE 11--Continued

Units		Taught in Depth No.	Taught in Depth %	Emphasized No.	Emphasized %	Discussed Briefly No.	Discussed Briefly %	Not Taught No.	Not Taught %
Current Gain	R (78)	32	41.0	35	44.9	10	12.8	1	1.3
	T (21)	7	33.3	11	52.4	3	14.3	0	0.0
	B (59)	35	59.3	20	33.9	4	6.8	0	0.0
	M (15)	5	33.3	10	66.7	0	0.0	0	0.0
	Totals (173)	79	45.7	76	43.9	17	9.8	1	0.6
Junction Type Transistors	R (78)	27	34.6	31	39.7	18	23.1	2	2.6
	T (21)	7	33.3	10	47.6	4	19.0	0	0.0
	B (59)	28	47.5	29	49.2	2	3.4	0	0.0
	M (15)	5	33.3	6	40.0	4	26.7	0	0.0
	Totals (173)	67	38.7	76	43.9	28	16.2	2	1.2
Static Characteristic Curves	R (78)	29	37.2	37	47.4	9	11.5	3	3.8
	T (21)	5	23.8	10	47.6	6	28.6	0	0.0
	B (59)	24	40.7	26	44.1	9	15.3	0	0.0
	M (15)	3	20.0	8	53.3	4	26.7	0	0.0
	Totals (173)	61	35.3	81	46.8	28	16.2	3	1.7
Dynamic Transfer Curves	R (78)	29	37.2	38	48.7	7	9.0	4	5.1
	T (21)	4	19.0	11	52.4	6	28.6	0	0.0
	B (59)	22	57.2	29	49.2	8	13.6	0	0.0
	M (15)	3	20.0	7	46.7	4	26.7	1	6.7
	Totals (173)	58	33.5	85	49.1	25	14.5	5	2.9

TABLE 11--Continued

Units		Taught in Depth No.	Taught in Depth %	Emphasized No.	Emphasized %	Discussed Briefly No.	Discussed Briefly %	Not Taught No.	Not Taught %
Transistor Biasing	R (78)	38	48.7	30	38.5	7	9.0	3	3.8
	T (21)	6	28.6	12	57.1	3	14.3	0	0.0
	B (59)	36	61.0	19	32.2	3	5.1	1	1.7
	M (15)	9	60.0	6	40.0	0	0.0	0	0.0
	Totals (173)	89	51.4	67	38.7	13	7.5	4	2.3
Physical Circuit Operation (NPN and PNP)	R (78)	41	52.6	30	38.5	5	6.4	2	2.6
	T (21)	8	38.1	10	47.6	3	14.3	0	0.0
	B (59)	39	66.1	17	28.8	2	3.4	1	1.7
	M (15)	8	53.3	5	33.3	2	13.3	0	0.0
	Totals (173)	96	55.5	62	35.8	12	6.9	3	1.7
Load Lines	R (78)	32	41.0	31	39.7	13	16.7	2	2.6
	T (21)	6	28.6	11	52.4	4	19.0	0	0.0
	B (59)	20	33.9	34	57.6	5	8.5	0	0.0
	M (15)	4	26.7	4	26.7	7	46.7	0	0.0
	Totals (173)	62	35.8	80	46.2	29	16.8	2	1.2
Graphical Analysis	R (78)	25	32.1	29	37.2	19	24.4	5	6.4
	T (21)	4	19.0	11	52.4	6	28.6	0	0.0
	B (59)	15	25.4	30	50.8	13	22.0	1	1.7
	M (15)	2	13.3	3	20.0	10	66.7	0	0.0
	Totals (173)	46	26.6	73	42.2	48	27.7	6	3.5

TABLE 11--Continued

Units		Taught in Depth No.	Taught in Depth %	Emphasized No.	Emphasized %	Discussed Briefly No.	Discussed Briefly %	Not Taught No.	Not Taught %
Thermal Properties	R (78)	29	37.2	37	47.4	9	11.5	3	3.8
	T (21)	4	19.0	12	57.1	5	23.8	0	0.0
	B (59)	20	33.9	28	47.5	11	18.6	0	0.0
	M (15)	4	26.7	7	46.7	4	26.7	0	0.0
	Totals (173)	57	32.9	84	48.6	29	16.8	3	1.7
Operating Point	R (78)	32	41.0	34	43.6	9	11.5	3	3.8
	T (21)	4	19.0	13	61.9	4	19.0	0	0.0
	B (59)	26	44.1	28	47.5	5	8.5	0	0.0
	M (15)	4	26.7	8	53.3	3	20.0	0	0.0
	Totals (173)	66	38.2	83	48.0	21	12.1	3	1.7
Transistor Noise	R (78)	17	21.8	41	52.6	17	21.8	3	3.8
	T (21)	8	53.3	9	60.0	4	26.7	0	0.0
	B (59)	21	35.6	29	49.2	8	13.6	1	1.7
	M (15)	4	26.7	7	46.7	4	26.7	0	0.0
	Totals (173)	50	28.9	86	49.7	33	19.1	4	2.3
"R" Parameter	R (78)	12	15.4	36	46.2	22	28.2	8	10.3
	T (21)	5	23.8	8	38.1	8	38.1	0	0.0
	B (59)	17	28.8	29	49.2	12	20.3	1	1.7
	M (15)	2	13.3	0	0.0	13	86.7	0	0.0
	Totals (173)	36	20.8	73	42.2	55	31.8	9	5.2

TABLE 11--Continued

Units		Taught in Depth No.	Taught in Depth %	Emphasized No.	Emphasized %	Discussed Briefly No.	Discussed Briefly %	Not Taught No.	Not Taught %
Hybrid Parameters	R (78)	18	23.1	34	43.6	19	24.4	7	9.0
	T (21)	5	23.8	9	42.9	6	28.6	1	4.8
	B (59)	15	25.4	29	49.2	13	22.0	2	3.4
	M (15)	2	13.3	0	0.0	13	86.7	0	0.0
	Totals (173)	40	23.1	72	41.6	51	29.5	10	5.8
Special Purpose Transistors:									
Tetrode Transistors	R (78)	13	16.7	28	35.9	28	35.9	9	11.5
	T (21)	6	28.6	10	47.6	4	19.0	1	4.8
	B (59)	25	42.3	21	35.6	12	20.3	1	1.7
	M (15)	3	20.0	4	26.7	7	46.7	1	6.7
	Totals (173)	47	27.2	63	36.4	51	29.5	12	6.9
Photosensitive Transistors	R (78)	16	20.5	32	41.0	26	33.3	4	5.1
	T (21)	7	33.3	7	33.3	6	28.6	1	4.8
	B (59)	24	40.7	19	32.2	16	27.1	0	0.0
	M (15)	5	33.3	2	13.3	8	53.3	0	0.0
	Totals (173)	52	30.1	60	34.7	56	32.4	5	2.9
Power Transistors	R (78)	28	35.9	36	46.2	11	14.1	3	3.8
	T (21)	8	38.1	9	42.9	4	19.0	0	0.0
	B (59)	34	57.6	20	33.9	5	8.5	0	0.0
	M (15)	5	33.3	6	40.0	4	26.7	0	0.0
	Totals (173)	75	43.4	71	41.0	24	13.9	3	1.7

TABLE 11--Continued

Units		Taught in Depth		Emphasized		Discussed Briefly		Not Taught	
		No.	%	No.	%	No.	%	No.	%
Unijunction Transistors	R (78)	24	30.8	37	47.4	14	17.9	3	3.8
	T (21)	8	38.1	8	38.1	4	19.0	1	4.8
	B (59)	27	45.8	25	42.3	6	10.1	1	1.7
	M (15)	4	26.7	3	20.0	8	53.3	0	0.0
	Totals (173)	63	36.4	73	42.2	32	18.5	5	2.9
Field-Effect Transistors	R (78)	32	41.0	33	42.3	9	11.5	4	5.1
	T (21)	6	28.6	10	47.6	4	19.0	1	4.8
	B (59)	37	62.7	17	28.8	5	8.5	0	0.0
	M (15)	5	33.3	7	46.7	3	20.0	0	0.0
	Totals (173)	80	46.2	67	38.7	21	12.1	5	2.9
Thyristors	R (78)	19	24.4	34	43.6	19	24.4	6	7.7
	T (21)	6	28.6	8	38.1	6	28.6	1	4.8
	B (59)	17	28.8	31	52.5	11	18.6	0	0.0
	M (15)	4	26.7	4	26.7	6	40.0	1	6.7
	Totals (173)	46	26.6	77	44.5	42	24.3	8	4.6
Microcircuits (Including Integrated Circuits)	R (78)	33	42.3	31	39.7	10	12.8	4	5.1
	T (21)	9	42.9	8	38.1	3	14.3	1	4.8
	B (59)	43	72.9	10	16.9	6	10.1	0	0.0
	M (15)	6	40.0	4	26.7	5	33.3	0	0.0
	Totals (173)	91	52.6	53	30.6	24	13.9	5	2.9

TABLE 11--Continued

Units		Taught in Depth		Empha-sized		Discussed Briefly		Not Taught	
		No.	%	No.	%	No.	%	No.	%
BASIC CIRCUITS AND SYSTEMS									
Power Supplies:									
Half and Full Wave Rectifiers	R (78)	40	51.3	29	37.2	9	11.5	0	0.0
	T (21)	11	52.4	10	47.6	0	0.0	0	0.0
	B (59)	32	54.2	22	37.2	5	8.5	0	0.0
	M (15)	9	60.0	4	26.7	2	13.3	0	0.0
	Totals (173)	92	53.2	65	37.6	16	9.2	0	0.0
Principles of Filtering	R (78)	40	51.3	31	39.7	7	9.0	0	0.0
	T (21)	11	52.4	10	47.6	0	0.0	0	0.0
	B (59)	27	45.8	27	45.8	5	8.5	0	0.0
	M (15)	7	46.7	6	40.0	2	13.3	0	0.0
	Totals (173)	85	49.1	74	42.8	14	8.1	0	0.0
Voltage Dividers and Doublers	R (78)	25	32.1	37	47.4	16	20.5	0	0.0
	T (21)	8	38.1	12	57.1	1	4.8	0	0.0
	B (59)	26	44.1	28	47.5	5	8.5	0	0.0
	M (15)	6	40.0	4	26.7	5	33.3	0	0.0
	Totals (173)	65	37.6	81	46.8	27	15.6	0	0.0
Polyphase Power Supplies	R (78)	16	20.5	33	42.3	26	33.3	3	3.8
	T (21)	7	33.3	12	57.1	2	9.5	0	0.0
	B (59)	13	22.0	34	57.6	11	18.6	1	1.7
	M (15)	3	20.0	4	26.7	6	40.0	2	13.3
	Totals (173)	39	22.5	83	48.0	45	26.0	6	3.5

TABLE 11--Continued

Units		Taught in Depth No.	Taught in Depth %	Empha-sized No.	Empha-sized %	Discussed Briefly No.	Discussed Briefly %	Not Taught No.	Not Taught %
R-F Power Supplies	R (78)	11	14.1	29	37.2	34	43.6	4	5.1
	T (21)	7	33.3	13	61.9	1	4.8	0	0.0
	B (59)	17	28.8	34	57.6	8	13.6	0	0.0
	M (15)	3	20.0	4	26.7	6	40.0	2	13.3
	Totals (173)	38	22.0	80	46.2	49	28.3	6	3.5
Voltage-Regulator Circuits	R (78)	29	37.2	36	46.2	13	16.7	0	0.0
	T (21)	8	38.1	11	52.4	2	9.5	0	0.0
	B (59)	29	49.2	25	42.3	4	6.8	1	1.7
	M (15)	7	46.7	5	33.3	3	20.0	0	0.0
	Totals (173)	73	42.2	77	44.5	22	12.7	1	0.6
Power Supply Troubleshooting	R (78)	39	50.0	27	34.6	11	14.1	1	1.3
	T (21)	10	47.6	9	42.9	1	6.7	1	6.7
	B (59)	31	52.5	21	35.6	7	11.9	0	0.0
	M (15)	7	46.7	6	40.0	1	6.7	1	6.7
	Totals (173)	87	50.3	63	36.4	20	11.6	3	1.7
Amplifier Fundamentals: Biasing and Classes of Operation (A, B, C, etc.)	R (78)	27	34.6	37	47.4	11	14.1	3	3.8
	T (21)	5	23.8	11	52.4	2	9.5	3	14.3
	B (59)	28	47.5	21	35.6	3	5.1	7	11.9
	M (15)	7	46.7	6	40.0	2	13.3	0	0.0
	Totals (173)	67	38.7	75	43.4	18	10.4	13	7.5

TABLE 11--Continued

Units		Taught in Depth No.	Taught in Depth %	Empha-sized No.	Empha-sized %	Discussed Briefly No.	Discussed Briefly %	Not Taught No.	Not Taught %
Decibels	R (78)	20	25.6	40	51.3	16	20.5	2	2.6
	T (21)	12	57.1	8	38.1	1	4.8	0	0.0
	B (59)	23	39.0	32	54.2	4	6.8	0	0.0
	M (15)	4	26.7	5	33.3	5	33.3	1	6.7
	Totals (173)	59	34.1	85	49.1	26	15.0	3	1.7
Stereophonic Sound	R (78)	3	3.8	17	21.8	42	53.8	16	20.5
	T (21)	3	14.3	9	42.9	8	38.1	1	4.8
	B (59)	18	30.5	26	44.1	15	25.4	0	0.0
	M (15)	2	13.3	6	40.0	6	40.0	1	6.7
	Totals (173)	26	15.0	58	33.5	71	41.0	18	10.4
D-C Amplifier Gain	R (78)	28	35.9	33	42.3	15	19.2	2	2.6
	T (21)	10	47.6	8	38.1	3	14.3	0	0.0
	B (59)	21	35.6	31	52.5	7	11.9	0	0.0
	M (15)	4	26.7	7	46.7	4	26.7	0	0.0
	Totals (173)	63	36.4	79	45.7	29	16.8	2	1.2
A-C Amplifier Gain	R (78)	27	34.6	33	42.3	17	21.8	1	1.3
	T (21)	10	47.6	8	38.1	3	14.3	0	0.0
	B (59)	24	40.7	28	47.5	7	11.9	0	0.0
	M (15)	4	26.7	6	40.0	5	33.3	0	0.0
	Totals (173)	65	37.6	75	43.4	32	18.5	1	0.6

TABLE 11--Continued

Units		Taught in Depth No.	Taught in Depth %	Empha-sized No.	Empha-sized %	Discussed Briefly No.	Discussed Briefly %	Not Taught No.	Not Taught %
Magnetic Amplifiers	R (78)	15	19.2	23	29.5	36	46.2	4	5.1
	T (21)	8	38.1	6	28.6	7	33.3	0	0.0
	B (59)	17	28.8	26	44.1	16	27.1	0	0.0
	M (15)	2	13.3	6	40.0	6	40.0	1	6.7
	Totals (173)	42	24.3	61	35.3	65	37.6	5	2.9
Frequency Response	R (78)	21	26.9	39	50.0	16	20.5	2	2.6
	T (21)	10	47.6	8	38.1	3	14.3	0	0.0
	B (59)	30	50.8	25	42.3	4	6.8	0	0.0
	M (15)	5	33.3	3	20.0	6	40.0	1	6.7
	Totals (173)	66	38.2	75	43.4	29	16.8	3	1.7
Basic Vacuum Tube Amplifiers and Circuits:									
Paraphase Amplifiers	R (78)	2	2.6	22	28.2	42	53.8	12	15.4
	T (21)	3	14.3	10	47.6	7	33.3	1	4.8
	B (59)	6	10.1	27	45.8	24	40.7	2	3.4
	M (15)	0	0.0	6	40.0	7	46.7	2	13.3
	Totals (173)	11	6.4	65	37.6	80	46.2	17	9.8
Cathode Follower A-F Amplifiers	R (78)	5	6.4	29	37.2	37	47.5	7	9.0
	T (21)	3	14.3	11	52.4	7	33.3	0	0.0
	B (59)	10	16.9	29	49.2	20	33.9	0	0.0
	M (15)	0	0.0	7	46.7	7	46.7	1	6.7
	Totals (173)	18	10.4	76	43.9	71	41.0	8	4.6

TABLE 11--Continued

Units		Taught in Depth No.	Taught in Depth %	Empha-sized No.	Empha-sized %	Discussed Briefly No.	Discussed Briefly %	Not Taught No.	Not Taught %
Push-Pull A-F Amplifiers	R (78)	5	6.4	28	35.9	39	50.0	6	7.7
	T (21)	2	9.5	12	57.1	7	33.3	0	0.0
	B (59)	12	20.3	35	59.3	12	20.3	0	0.0
	M (15)	1	6.7	7	46.7	6	40.0	1	6.7
	Totals (173)	20	11.6	82	47.4	64	37.0	7	4.0
I-F Amplifiers	R (78)	6	7.7	24	30.8	39	50.0	9	11.5
	T (21)	2	9.5	12	57.1	6	28.6	1	4.8
	B (59)	13	22.0	32	54.2	14	23.7	0	0.0
	M (15)	1	6.7	7	46.7	6	40.0	1	6.7
	Totals (173)	22	12.7	75	43.4	65	37.6	11	6.4
Amplifier Coupling	R (78)	9	11.5	25	32.1	37	47.4	7	9.0
	T (21)	2	9.5	14	66.7	5	23.8	0	0.0
	B (59)	13	22.0	30	50.8	16	27.1	0	0.0
	M (15)	1	6.7	7	46.7	6	40.0	1	6.7
	Totals (173)	25	14.5	76	43.9	64	37.0	8	4.6
Audio Preamplifier Circuits	R (78)	7	9.0	23	29.5	38	48.7	10	12.8
	T (21)	2	9.5	16	76.2	3	14.3	0	0.0
	B (59)	15	25.4	30	50.8	14	23.7	0	0.0
	M (15)	1	6.7	6	40.0	7	46.7	1	6.7
	Totals (173)	25	14.5	75	43.4	62	35.8	11	6.4

TABLE 11--Continued

Units		Taught in Depth No.	Taught in Depth %	Emphasized No.	Emphasized %	Discussed Briefly No.	Discussed Briefly %	Not Taught No.	Not Taught %
Audio-Output Stage	R (78)	6	7.7	25	32.1	38	48.7	9	11.5
	T (21)	2	9.5	17	81.0	2	9.5	0	0.0
	B (59)	15	25.4	30	50.8	14	23.7	0	0.0
	M (15)	1	6.7	6	40.0	7	46.7	1	6.7
	Totals (173)	24	13.9	78	45.1	61	35.3	10	5.8
Tone Control Circuits	R (78)	4	5.1	17	21.8	44	56.4	13	16.7
	T (21)	4	19.0	11	52.4	5	23.8	1	4.8
	B (59)	7	11.9	26	44.1	25	42.3	1	1.7
	M (15)	0	0.0	6	40.0	6	40.0	3	20.0
	Totals (173)	15	8.7	60	34.7	80	46.2	18	10.4
Bandpass Amplifier Circuits	R (78)	6	7.7	24	30.8	38	48.7	10	12.8
	T (21)	4	19.0	12	57.1	4	19.0	1	4.8
	B (59)	9	15.3	28	47.5	22	37.2	0	0.0
	M (15)	0	0.0	7	46.7	5	33.3	3	20.0
	Totals (173)	19	11.0	71	41.0	69	39.9	14	8.1
Attenuators	R (78)	6	7.7	23	29.5	38	48.7	11	14.1
	T (21)	4	19.0	13	61.9	4	19.0	0	0.0
	B (59)	13	22.0	28	47.5	17	28.8	1	1.7
	M (15)	0	0.0	3	20.0	9	60.0	3	20.0
	Totals (173)	23	13.3	67	38.7	68	39.3	15	8.7

TABLE 11--Continued

Units		Taught in Depth		Empha-sized		Discussed Briefly		Not Taught	
		No.	%	No.	%	No.	%	No.	%
Audio-Output Stage	R (78)	6	7.7	25	32.1	38	48.7	9	11.5
	T (21)	2	9.5	17	81.0	2	9.5	0	0.0
	B (59)	15	25.4	30	50.8	14	23.7	0	0.0
	M (15)	1	6.7	6	40.0	7	46.7	1	6.7
	Totals (173)	24	13.9	78	45.1	61	35.3	10	5.8
Tone Control Circuits	R (78)	4	5.1	17	21.8	44	56.4	13	16.7
	T (21)	4	19.0	11	52.4	5	23.8	1	4.8
	B (59)	7	11.9	26	44.1	25	42.3	1	1.7
	M (15)	0	0.0	6	40.0	6	40.0	3	20.0
	Totals (173)	15	8.7	60	34.7	80	46.2	18	10.4
Bandpass Amplifier Circuits	R (78)	6	7.7	24	30.8	38	48.7	10	12.8
	T (21)	4	19.0	12	57.1	4	19.0	1	4.8
	B (59)	9	15.3	28	47.5	22	37.2	0	0.0
	M (15)	0	0.0	7	46.7	5	33.3	3	20.0
	Totals (173)	19	11.0	71	41.0	69	39.9	14	8.1
Attenuators	R (78)	6	7.7	23	29.5	38	48.7	11	14.1
	T (21)	4	19.0	13	61.9	4	19.0	0	0.0
	B (59)	13	22.0	28	47.5	17	28.8	1	1.7
	M (15)	0	0.0	3	20.0	9	60.0	3	20.0
	Totals (173)	23	13.3	67	38.7	68	39.3	15	8.7

TABLE 11--Continued

Units		Taught in Depth No.	Taught in Depth %	Emphasized No.	Emphasized %	Discussed Briefly No.	Discussed Briefly %	Not Taught No.	Not Taught %
Delayed-Action Circuits	R (78)	4	5.1	15	19.2	46	59.0	13	16.7
	T (21)	2	9.5	13	61.9	5	23.8	1	4.8
	B (59)	11	18.6	22	37.2	22	37.2	4	6.8
	M (15)	0	0.0	3	20.0	9	60.0	3	20.0
	Totals (173)	17	9.8	53	30.6	82	47.4	21	12.1
Loudspeakers:									
Headsets	R (78)	2	2.6	9	11.5	50	64.1	17	21.8
	T (21)	1	4.8	13	61.9	6	28.6	1	4.8
	B (59)	3	5.1	17	28.8	37	62.7	2	3.4
	M (15)	1	6.7	1	6.7	11	73.3	2	13.3
	Totals (173)	7	4.0	40	23.1	104	60.1	22	12.7
Dynamic Speakers	R (78)	2	2.6	12	15.4	49	62.8	15	19.2
	T (21)	0	0.0	14	66.7	5	23.8	2	9.5
	B (59)	7	11.9	19	32.2	32	54.2	1	1.7
	M (15)	1	6.7	3	20.0	10	66.7	1	6.7
	Totals (173)	10	5.8	48	27.7	96	55.5	19	11.0
Electrostatic Speakers	R (78)	2	2.6	14	17.9	44	56.4	18	23.1
	T (21)	2	9.5	12	57.1	5	23.8	2	9.5
	B (59)	5	8.5	19	32.2	32	54.2	3	5.1
	M (15)	1	6.7	1	6.7	12	80.0	1	6.7
	Totals (173)	10	5.8	46	26.6	93	53.8	24	13.9

TABLE 11--Continued

Units		Taught in Depth No.	Taught in Depth %	Emphasized No.	Emphasized %	Discussed Briefly No.	Discussed Briefly %	Not Taught No.	Not Taught %
P-M Speakers	R (78)	2	2.6	15	19.2	46	59.0	15	19.2
	T (21)	1	4.8	12	57.1	7	33.3	1	4.8
	B (59)	7	11.9	23	39.0	28	47.5	1	1.7
	M (15)	1	6.7	2	13.3	10	66.7	2	13.3
	Totals (173)	11	6.4	52	30.1	91	52.6	19	11.0
Speaker Enclosures	R (78)	1	1.3	10	12.8	45	57.7	22	28.2
	T (21)	0	0.0	9	42.9	10	47.6	2	9.5
	B (59)	10	16.9	20	33.9	27	45.8	2	3.4
	M (15)	1	6.7	1	6.7	10	66.7	3	20.0
	Totals (173)	12	6.9	40	23.1	92	53.2	29	16.8
Microphones and Pickups:									
Carbon	R (78)	3	3.8	10	12.8	48	61.5	17	21.8
	T (21)	1	4.8	11	52.4	8	38.1	1	4.8
	B (59)	5	8.5	8	13.6	39	66.1	7	11.9
	M (15)	1	6.7	2	13.3	10	66.7	2	13.3
	Totals (173)	10	5.8	31	17.9	105	60.7	27	15.6
Capacitor	R (78)	3	3.8	9	11.5	49	62.8	17	21.8
	T (21)	2	9.5	9	42.9	8	38.1	2	9.5
	B (59)	9	15.3	26	44.1	24	40.7	0	0.0
	M (15)	1	6.7	2	13.3	11	73.3	1	6.7
	Totals (173)	15	8.7	46	26.6	92	53.2	20	11.6

TABLE 11--Continued

Units		Taught in Depth		Empha-sized		Discussed Briefly		Not Taught	
		No.	%	No.	%	No.	%	No.	%
Crystal	R (78)	3	3.8	12	15.4	49	62.8	14	17.9
	T (21)	3	14.3	10	47.6	7	33.3	1	4.8
	B (59)	5	8.5	18	30.5	33	55.9	3	5.1
	M (15)	1	6.7	2	13.3	10	66.7	2	13.3
	Totals (173)	12	6.9	42	24.3	99	57.2	20	11.6
Dynamic	R (78)	5	6.4	11	14.1	49	62.8	13	16.7
	T (21)	4	19.0	8	38.1	8	38.1	1	4.8
	B (59)	12	20.3	31	52.5	16	27.1	0	0.0
	M (15)	1	6.7	2	13.3	11	73.3	1	6.7
	Totals (173)	22	12.7	52	30.1	84	48.6	15	8.7
Velocity	R (78)	4	5.1	10	12.8	49	62.8	15	19.2
	T (21)	3	14.3	8	38.1	9	42.9	1	4.8
	B (59)	10	16.9	24	40.7	25	42.3	0	0.0
	M (15)	1	6.7	1	6.7	12	80.0	1	6.7
	Totals (173)	18	10.4	43	24.9	95	54.9	17	9.8
Ceramic	R (78)	4	5.1	12	15.4	48	61.5	14	17.9
	T (21)	4	19.0	7	33.3	9	42.9	1	4.8
	B (59)	7	11.9	20	33.9	29	32.2	3	5.1
	M (15)	1	6.7	1	6.7	12	80.0	1	6.7
	Totals (173)	16	9.2	40	23.1	98	56.6	19	11.0

TABLE 11--Continued

Units		Taught in Depth No.	Taught in Depth %	Emphasized No.	Emphasized %	Discussed Briefly No.	Discussed Briefly %	Not Taught No.	Not Taught %
Oscillators:									
Phase-Shift Oscillators	R (78)	11	14.1	37	47.4	26	33.3	4	5.1
	T (21)	5	23.8	10	47.6	6	28.6	0	0.0
	B (59)	15	25.4	27	45.8	17	28.8	0	0.0
	M (15)	2	13.3	9	60.0	2	13.3	2	13.3
	Totals (173)	33	19.1	83	48.0	51	29.5	6	3.5
Tuned Plate-Grid Oscillators	R (78)	9	11.5	31	39.7	32	41.0	6	7.7
	T (21)	6	28.6	10	47.6	5	23.8	0	0.0
	B (59)	11	18.6	27	45.8	21	35.6	0	0.0
	M (15)	2	13.3	6	40.0	4	26.7	3	20.0
	Totals (173)	28	16.2	74	42.8	62	35.8	9	5.2
Hartley Oscillators	R (78)	11	14.1	32	41.0	32	41.0	3	3.8
	T (21)	5	23.8	10	47.6	6	28.6	0	0.0
	B (59)	14	23.7	29	49.2	16	27.1	0	0.0
	M (15)	2	13.3	9	60.0	3	20.0	1	6.7
	Totals (173)	32	18.5	80	46.2	57	32.9	4	2.3
Colpitts Oscillators	R (78)	9	11.5	33	42.3	33	42.3	3	5.8
	T (21)	4	19.0	11	52.4	6	28.6	0	0.0
	B (59)	14	23.7	29	49.2	16	27.1	0	0.0
	M (15)	2	13.3	9	60.0	3	20.0	1	6.7
	Totals (173)	29	16.8	82	47.4	58	33.5	4	2.3

TABLE 11--Continued

Units		Taught in Depth No.	Taught in Depth %	Emphasized No.	Emphasized %	Discussed Briefly No.	Discussed Briefly %	Not Taught No.	Not Taught %
Armstrong Oscillators	R (78)	8	10.3	29	37.2	38	48.7	3	3.8
	T (21)	4	19.0	11	52.4	6	28.6	0	0.0
	B (59)	13	22.0	26	44.1	20	33.9	0	0.0
	M (15)	2	13.3	4	26.7	7	46.7	2	13.3
	Totals (173)	27	15.6	70	40.5	71	41.0	5	2.9
Electron-Coupled Oscillators	R (78)	7	9.0	30	38.5	36	46.2	5	6.4
	T (21)	4	19.0	10	47.6	7	33.3	0	0.0
	B (59)	14	23.7	31	52.5	13	22.0	1	1.7
	M (15)	2	13.3	6	40.0	5	33.3	2	13.3
	Totals (173)	27	15.6	77	44.5	61	35.3	8	4.6
Pierce Oscillators	R (78)	7	9.0	28	35.9	37	47.4	6	7.7
	T (21)	3	14.3	11	52.4	7	33.3	0	0.0
	B (59)	15	25.4	27	45.8	16	27.1	1	1.7
	M (15)	2	13.3	6	40.0	5	33.3	2	13.3
	Totals (173)	27	15.6	72	41.6	65	37.6	9	5.2
Crystal Overtone Oscillators	R (78)	8	10.3	27	34.6	37	47.4	6	7.7
	T (21)	5	23.8	9	42.9	6	28.6	1	4.8
	B (59)	18	30.5	28	47.5	13	22.0	0	0.0
	M (15)	3	20.0	5	33.3	5	33.3	2	13.3
	Totals (173)	34	19.7	69	39.9	61	35.3	9	5.2

TABLE 11--Continued

Units		Taught in Depth No.	Taught in Depth %	Emphasized No.	Emphasized %	Discussed Briefly No.	Discussed Briefly %	Not Taught No.	Not Taught %
R-F Amplifiers and Circuits:									
R-F Amplifier Circuits (General)	R (78)	16	20.5	34	43.6	24	30.8	4	5.1
	T (21)	5	23.8	14	66.7	2	9.5	0	0.0
	B (59)	22	37.2	31	52.5	6	10.1	0	0.0
	M (15)	4	26.7	7	46.7	3	20.0	1	6.7
	Totals (173)	47	27.2	86	49.7	35	20.2	5	2.9
R-F Power Amplifiers	R (78)	12	15.4	33	42.3	28	35.9	5	6.4
	T (21)	4	19.0	15	71.4	2	9.5	0	0.0
	B (59)	23	39.0	29	49.2	7	11.9	0	0.0
	M (15)	2	13.3	7	46.7	5	33.3	1	6.7
	Totals (173)	41	23.7	84	48.6	42	24.3	6	3.5
Wide-Band Amplifiers	R (78)	9	11.5	32	41.0	31	39.7	6	7.7
	T (21)	4	19.0	16	76.2	1	4.8	0	0.0
	B (59)	18	30.5	31	52.5	10	16.9	0	0.0
	M (15)	2	13.3	8	53.3	4	26.7	1	6.7
	Totals (173)	33	19.1	87	50.3	46	26.6	7	4.0
Single and Double Tuned Circuits	R (78)	8	10.3	26	33.3	37	47.4	7	9.0
	T (21)	3	14.3	13	61.9	4	19.0	1	4.8
	B (59)	13	22.0	31	52.5	14	23.7	1	1.7
	M (15)	3	20.0	7	46.7	5	33.3	0	0.0
	Totals (173)	27	15.6	77	44.5	60	34.7	9	5.2

TABLE 11--Continued

Units		Taught in Depth No.	Taught in Depth %	Emphasized No.	Emphasized %	Discussed Briefly No.	Discussed Briefly %	Not Taught No.	Not Taught %
Neutralizing Circuits	R (78)	7	9.0	26	33.3	36	46.2	9	11.5
	T (21)	2	9.5	16	76.2	2	9.5	1	4.8
	B (59)	17	28.8	25	42.3	17	28.8	0	0.0
	M (15)	1	6.7	7	46.7	7	46.7	0	0.0
	Totals (173)	27	15.6	74	42.8	62	35.8	10	5.8
R-F Buffer and Frequency Multipliers	R (78)	7	9.0	26	33.3	36	46.2	9	11.5
	T (21)	4	19.0	12	57.1	5	23.8	0	0.0
	B (59)	18	30.5	28	47.5	13	22.0	0	0.0
	M (15)	2	13.3	5	33.3	7	46.7	1	6.7
	Totals (173)	31	17.9	71	41.0	61	35.3	10	5.8
Troubleshooting Procedures	R (78)	19	24.4	26	33.3	24	30.8	9	11.5
	T (21)	6	28.6	13	61.9	2	9.5	0	0.0
	B (59)	36	61.0	13	22.0	9	15.3	1	1.7
	M (15)	6	40.0	4	26.7	4	26.7	1	6.7
	Totals (173)	67	38.7	56	32.4	39	22.5	11	6.4
Transmitter Fundamentals:									
C-W Transmitter Keying	R (78)	2	2.6	11	14.1	48	61.5	17	21.8
	T (21)	2	9.5	13	61.9	3	14.3	3	14.3
	B (59)	5	8.5	17	28.5	32	54.2	5	8.5
	M (15)	0	0.0	4	26.7	10	66.7	1	6.7
	Totals (173)	9	5.2	45	26.0	93	53.8	26	15.0

TABLE 11--Continued

Units		Taught in Depth		Empha-sized		Discussed Briefly		Not Taught	
		No.	%	No.	%	No.	%	No.	%
Classification of Wave Emission	R (78)	3	3.8	18	23.1	43	55.1	14	17.9
	T (21)	3	14.3	11	52.4	6	28.6	1	4.8
	B (59)	9	15.3	18	30.5	31	52.5	1	1.7
	M (15)	0	0.0	5	33.3	10	66.7	0	0.0
	Totals (173)	15	8.7	52	30.1	90	52.0	16	9.2
Parasitics and Harmonics	R (78)	4	5.1	19	24.4	41	52.6	14	17.9
	T (21)	3	14.3	12	57.1	5	23.8	1	4.8
	B (59)	18	30.5	31	52.5	10	16.9	0	0.0
	M (15)	0	0.0	8	53.3	7	46.7	0	0.0
	Totals (173)	25	14.5	70	40.5	63	36.4	15	8.7
Power Distribution in A-M Wave	R (78)	4	5.1	13	16.7	47	60.3	14	17.9
	T (21)	3	14.3	11	52.4	5	23.8	2	9.5
	B (59)	10	16.9	32	52.4	17	28.8	0	0.0
	M (15)	0	0.0	6	40.0	9	60.0	0	0.0
	Totals (173)	17	9.8	62	35.8	78	45.1	16	9.2
Transmitter Measurements	R (78)	6	7.7	18	23.1	41	52.6	13	16.7
	T (21)	3	14.3	13	61.9	3	14.3	2	9.5
	B (59)	30	50.8	23	39.0	6	10.1	0	0.0
	M (15)	0	0.0	7	46.7	8	53.3	0	0.0
	Totals (173)	39	22.5	61	35.3	58	33.5	15	8.7

TABLE 11--Continued

Units		Taught in Depth No.	Taught in Depth %	Emphasized No.	Emphasized %	Discussed Briefly No.	Discussed Briefly %	Not Taught No.	Not Taught %
A-M, F-M Comparisons	R (78)	6	7.7	19	24.4	39	50.0	14	17.9
	T (21)	3	14.3	12	57.1	4	19.0	2	9.5
	B (59)	12	20.3	27	45.8	20	33.9	0	0.0
	M (15)	0	0.0	7	46.7	8	53.3	0	0.0
	Totals (173)	21	12.1	65	37.6	71	41.0	16	9.2
Transmitter Alignment	R (78)	6	7.7	19	24.4	37	47.4	16	20.5
	T (21)	5	23.8	10	47.6	4	19.0	2	9.5
	B (59)	26	44.1	25	42.3	6	10.1	2	3.4
	M (15)	1	6.7	6	40.0	7	46.7	1	6.7
	Totals (173)	38	22.0	60	34.7	54	31.2	21	12.1
Radio Transmitters and Circuits:									
C-W Transmitters	R (78)	3	3.8	14	17.9	45	57.7	16	20.5
	T (21)	3	14.3	10	47.6	6	28.6	2	9.5
	B (59)	5	8.5	20	33.9	28	47.5	6	10.1
	M (15)	0	0.0	6	40.0	8	53.3	1	6.7
	Totals (173)	11	6.4	50	28.9	87	50.3	25	14.5
VHF Transmitters	R (78)	5	6.4	17	21.8	39	50.0	17	21.8
	T (21)	5	23.8	9	42.9	5	23.8	2	9.5
	B (59)	30	50.8	25	42.3	3	5.1	1	1.7
	M (15)	0	0.0	6	40.0	8	53.3	1	6.7
	Totals (173)	40	23.1	57	32.9	55	31.8	21	12.1

TABLE 11--Continued

Units		Taught in Depth No.	Taught in Depth %	Emphasized No.	Emphasized %	Discussed Briefly No.	Discussed Briefly %	Not Taught No.	Not Taught %
UHF Transmitters	R (78)	5	6.4	18	23.1	38	48.7	17	21.8
	T (21)	4	19.0	10	47.6	5	23.8	2	9.5
	B (59)	36	61.0	19	32.2	3	5.1	1	1.7
	M (15)	0	0.0	6	40.0	8	53.3	1	6.7
	Totals (173)	45	26.0	53	30.6	54	31.2	21	12.1
A-M Transmitters and Circuits	R (78)	3	3.8	19	24.4	39	50.0	17	21.8
	T (21)	4	19.0	8	38.1	7	33.3	2	9.5
	B (59)	20	33.9	33	55.9	6	10.1	0	0.0
	M (15)	0	0.0	6	40.0	8	53.3	1	6.7
	Totals (173)	27	15.6	66	38.2	60	34.7	20	11.6
Sideband Transmitters	R (78)	6	7.7	20	25.6	34	43.6	18	23.1
	T (21)	3	14.3	11	52.4	5	23.8	2	9.5
	B (59)	26	44.1	25	42.3	8	13.6	0	0.0
	M (15)	0	0.0	7	46.7	7	46.7	1	6.7
	Totals (173)	35	20.2	63	36.4	54	31.2	21	12.1
F-M (Reactance Tube) Transmitters	R (78)	6	7.7	15	19.2	37	47.4	20	25.6
	T (21)	3	14.3	11	52.4	5	23.8	2	9.5
	B (59)	18	30.5	31	52.5	10	16.9	0	0.0
	M (15)	0	0.0	4	26.7	10	66.7	1	6.7
	Totals (173)	27	15.6	61	35.3	62	35.8	23	13.3

TABLE 11--Continued

Units		Taught in Depth No.	Taught in Depth %	Emphasized No.	Emphasized %	Discussed Briefly No.	Discussed Briefly %	Not Taught No.	Not Taught %
F-M (Phase) Transmitters	R (78)	6	7.7	16	20.5	40	51.3	16	20.5
	T (21)	3	14.3	12	57.1	4	19.0	2	9.5
	B (59)	21	35.6	30	50.8	7	11.9	1	1.7
	M (15)	0	0.0	5	33.3	9	60.0	1	6.7
	Totals (173)	30	17.3	63	36.4	60	34.7	20	11.6
Troubleshooting Procedures	R (78)	12	15.4	20	25.6	30	38.5	16	20.5
	T (21)	6	28.6	11	52.4	2	9.5	2	9.5
	B (59)	39	66.1	14	23.7	5	8.5	1	1.7
	M (15)	3	20.0	6	40.0	5	33.3	1	6.7
	Totals (173)	60	34.7	51	29.5	42	24.3	20	11.6
Transmission of Radio Waves:									
Principles of Radiation and Propagation	R (78)	17	21.8	25	32.1	22	28.2	14	17.9
	T (21)	8	38.1	6	28.6	5	23.8	2	9.5
	B (59)	21	35.6	27	45.8	7	11.9	4	6.8
	M (15)	1	6.7	6	40.0	6	40.0	2	13.3
	Totals (173)	47	27.2	64	37.0	40	23.1	22	12.7
Antenna Fundamentals	R (78)	10	12.8	21	26.9	32	41.0	15	19.2
	T (21)	4	19.0	11	52.4	5	23.8	1	4.8
	B (59)	24	40.7	31	52.5	4	6.8	0	0.0
	M (15)	2	13.3	7	46.7	6	40.0	0	0.0
	Totals (173)	40	23.1	70	40.5	47	27.2	16	9.2

TABLE 11--Continued

Units		Taught in Depth		Emphasized		Discussed Briefly		Not Taught	
		No.	%	No.	%	No.	%	No.	%
Transmission Line Theory	R (78)	11	14.1	24	30.8	27	34.6	16	20.5
	T (21)	3	14.3	13	61.9	4	19.0	1	4.8
	B (59)	27	45.8	26	44.1	6	10.1	0	0.0
	M (15)	2	13.3	5	33.3	7	46.7	1	6.7
	Totals (173)	43	24.9	68	39.3	44	25.4	18	10.4
Types of Antennas	R (78)	7	9.0	28	35.9	27	34.6	16	20.5
	T (21)	4	19.0	10	47.6	5	23.8	2	9.5
	B (59)	21	35.6	26	44.1	12	20.3	0	0.0
	M (15)	1	6.7	6	40.0	6	40.0	2	13.3
	Totals (173)	33	19.1	70	40.5	50	28.9	20	11.6
FCC Regulations	R (78)	3	3.8	19	24.4	34	43.6	22	28.2
	T (21)	10	47.6	7	33.3	3	14.3	1	4.8
	B (59)	26	44.1	22	37.2	8	13.6	3	5.1
	M (15)	0	0.0	6	40.0	7	46.7	2	13.3
	Totals (173)	39	22.5	54	31.2	52	30.1	28	16.2
Radio Receiver Fundamentals:									
Reading Schematic Diagrams	R (78)	30	38.5	20	25.6	16	20.5	12	15.4
	T (21)	13	61.9	6	28.6	1	4.8	1	4.8
	B (59)	34	57.6	22	37.2	3	5.1	0	0.0
	M (15)	7	46.7	5	33.3	3	20.0	0	0.0
	Totals (173)	84	48.6	53	30.6	23	13.3	13	7.5

TABLE 11--Continued

Units		Taught in Depth No.	Taught in Depth %	Emphasized No.	Emphasized %	Discussed Briefly No.	Discussed Briefly %	Not Taught No.	Not Taught %
Heterodyning Principles	R (78)	7	9.0	24	30.8	34	43.6	13	16.7
	T (21)	2	9.5	12	57.1	7	33.3	0	0.0
	B (59)	13	22.0	36	61.0	8	13.6	2	3.4
	M (15)	4	26.7	5	33.3	5	33.3	1	6.7
	Totals (173)	26	15.0	77	44.5	54	31.2	16	9.2
A-M Detection	R (78)	6	7.7	30	38.5	31	39.7	11	14.1
	T (21)	2	9.5	11	52.4	7	33.3	1	4.8
	B (59)	10	16.9	40	67.8	9	15.3	0	0.0
	M (15)	4	26.7	4	26.7	7	46.7	0	0.0
	Totals (173)	22	12.7	85	49.1	54	31.2	12	6.9
F-M Detection	R (78)	6	7.7	31	39.7	30	38.5	11	14.1
	T (21)	2	9.5	13	61.9	5	23.8	1	4.8
	B (59)	11	18.6	40	67.8	8	13.6	0	0.0
	M (15)	4	26.7	4	26.7	7	46.7	0	0.0
	Totals (173)	23	13.3	88	50.9	50	28.9	12	6.9
Alignment Procedures	R (78)	7	9.0	25	32.1	31	39.7	15	19.2
	T (21)	7	33.3	10	47.6	3	14.3	1	4.8
	B (59)	18	30.5	34	57.6	7	11.9	0	0.0
	M (15)	5	33.3	4	26.7	5	33.3	1	6.7
	Totals (173)	37	21.4	73	42.2	46	26.6	17	9.8

TABLE 11--Continued

		Taught in Depth		Empha-sized		Discussed Briefly		Not Taught	
		No.	%	No.	%	No.	%	No.	%
Troubleshooting Procedures	R (78)	16	20.5	22	28.2	25	32.1	15	19.2
	T (21)	10	47.6	8	38.1	2	9.5	1	4.8
	B (59)	31	52.5	19	32.2	9	15.3	0	0.0
	M (15)	5	33.3	5	33.3	4	26.7	1	6.7
	Totals (173)	62	35.8	54	31.2	40	23.1	17	9.8
Radio Receivers and Circuits:									
T-R-F Receivers	R (78)	3	3.8	13	16.7	41	52.6	21	26.9
	T (51)	1	4.8	13	61.9	4	19.0	3	14.3
	B (59)	3	5.1	18	30.5	31	52.5	7	11.9
	M (15)	2	13.3	3	20.0	9	60.0	1	6.7
	Totals (173)	9	5.2	47	27.2	85	49.1	32	18.5
Superhet Receivers (General)	R (78)	5	6.4	24	30.8	37	47.4	12	15.4
	T (21)	2	9.5	14	66.7	4	19.0	1	4.8
	B (59)	8	13.6	44	74.6	7	11.9	0	0.0
	M (15)	2	13.3	7	46.7	5	33.3	1	6.7
	Totals (173)	17	9.8	89	51.4	53	30.6	14	8.1
AM-FM Receivers	R (78)	5	6.4	24	30.8	36	46.2	13	16.7
	T (21)	4	19.0	10	47.6	6	28.6	1	4.8
	B (59)	11	18.6	38	64.4	9	15.3	1	1.7
	M (15)	3	20.0	6	40.0	5	33.3	1	6.7
	Totals (173)	23	13.3	78	45.1	56	32.4	16	9.2

TABLE 11--Continued

Units		Taught in Depth No.	Taught in Depth %	Emphasized No.	Emphasized %	Discussed Briefly No.	Discussed Briefly %	Not Taught No.	Not Taught %
Sideband Receivers	R (78)	9	11.5	18	23.1	38	48.7	13	16.7
	T (21)	1	4.8	14	66.7	4	19.0	2	9.5
	B (59)	15	25.4	34	57.6	9	15.3	1	1.7
	M (15)	2	13.3	6	40.0	4	26.7	3	20.0
	Totals (173)	27	15.6	72	41.6	55	31.8	19	11.0
Special Receiver Circuits	R (78)	6	7.7	16	20.5	41	52.6	15	19.2
	T (21)	4	19.0	11	52.4	5	23.8	1	4.8
	B (59)	10	16.9	34	57.6	14	23.7	1	1.7
	M (15)	2	13.3	2	13.3	9	60.0	2	13.3
	Totals (173)	22	12.7	63	36.4	69	39.9	19	11.0
AVC Circuits	R (78)	6	7.7	15	19.2	44	56.4	13	16.7
	T (21)	1	4.8	14	66.7	6	28.6	0	0.0
	B (59)	5	8.5	41	69.5	13	22.0	0	0.0
	M (15)	1	6.7	7	46.7	6	40.0	1	6.7
	Totals (173)	13	7.5	77	44.5	69	39.9	14	8.1
The B+ Supply	R (78)	5	6.4	16	20.5	43	55.1	14	17.9
	T (21)	1	4.8	17	76.2	4	19.0	0	0.0
	B (59)	11	18.6	32	54.2	16	27.1	0	0.0
	M (15)	1	6.7	4	26.7	8	53.3	2	13.3
	Totals (173)	18	10.4	68	39.3	71	41.0	16	9.2

TABLE 11--Continued

Units		Taught in Depth No.	Taught in Depth %	Empha-sized No.	Empha-sized %	Discussed Briefly No.	Discussed Briefly %	Not Taught No.	Not Taught %
Squelch Circuits	R (78)	4	5.1	15	19.2	45	57.7	14	17.9
	T (21)	2	9.5	13	61.9	5	23.8	1	4.8
	B (59)	6	10.1	39	66.1	14	23.7	0	0.0
	M (15)	1	6.7	5	33.3	8	53.3	1	6.7
	Totals (173)	13	7.5	72	41.6	72	41.6	16	9.2
Limiters	R (78)	4	5.1	18	23.1	44	56.4	12	15.4
	T (21)	0	0.0	15	71.4	5	23.8	1	4.8
	B (59)	9	15.3	38	64.4	12	20.3	0	0.0
	M (15)	1	6.7	5	33.3	8	53.3	1	6.7
	Totals (173)	14	8.1	76	43.9	69	39.9	14	8.1
Discriminators	R (78)	6	7.7	18	23.1	41	52.6	13	16.7
	T (21)	1	4.8	14	66.7	6	28.6	0	0.0
	B (59)	7	11.9	41	69.5	11	18.6	0	0.0
	M (15)	1	6.7	7	46.7	6	40.0	1	6.7
	Totals (173)	15	8.7	80	46.2	64	37.0	14	8.1
TRANSISTOR CIRCUITS									
Transistor Amplifier Fundamentals:									
Reading Transistor Specifications	R (78)	46	59.0	20	25.6	10	12.8	2	2.6
	T (21)	13	61.9	5	23.8	3	14.3	0	0.0
	B (59)	28	47.5	30	50.8	1	1.7	0	0.0
	M (15)	8	53.3	2	13.3	5	33.3	0	0.0
	Totals (173)	95	54.9	57	32.9	19	11.0	2	1.2

TABLE 11--Continued

Units		Taught in Depth No.	Taught in Depth %	Emphasized No.	Emphasized %	Discussed Briefly No.	Discussed Briefly %	Not Taught No.	Not Taught %
Classes of Operation	R (78)	29	37.2	32	41.0	16	20.5	1	1.3
	T (21)	12	57.1	7	33.3	2	9.5	0	0.0
	B (59)	24	40.7	30	50.8	5	8.5	0	0.0
	M (15)	7	46.7	6	40.0	2	13.3	0	0.0
Totals	(173)	72	41.6	75	43.4	25	14.5	1	0.6
Current, Voltage, and Power Gain	R (78)	36	46.2	29	37.2	12	15.4	1	1.3
	T (21)	12	57.1	8	38.1	1	4.8	0	0.0
	B (59)	33	55.9	24	40.7	1	1.7	1	1.7
	M (15)	8	53.3	6	40.0	1	6.7	0	0.0
Totals	(173)	89	51.4	67	38.7	15	8.7	2	1.2
Base, Emitter, Collector Phase Relationships	R (78)	35	44.9	30	38.5	11	14.1	2	2.6
	T (21)	11	52.4	7	33.3	2	9.5	1	4.8
	B (59)	34	57.6	22	37.2	3	5.1	0	0.0
	M (15)	6	40.0	9	60.0	0	0.0	0	0.0
Totals	(173)	86	49.7	68	39.3	16	9.2	3	1.7
Input and Output Resistance	R (78)	29	37.2	35	44.9	13	16.7	1	1.3
	T (21)	10	47.6	9	42.9	2	9.5	0	0.0
	B (59)	34	57.6	21	35.6	4	6.8	0	0.0
	M (15)	6	40.0	6	40.0	3	20.0	0	0.0
Totals	(173)	79	45.7	71	41.0	22	12.7	1	0.6

TABLE 11--Continued

Units		Taught in Depth No.	Taught in Depth %	Emphasized No.	Emphasized %	Discussed Briefly No.	Discussed Briefly %	Not Taught No.	Not Taught %
Volume and Tone Controls	R (78)	13	16.7	25	32.1	29	37.2	11	14.1
	T (21)	8	38.1	10	47.6	3	14.3	0	0.0
	B (59)	15	25.4	26	44.1	18	30.5	0	0.0
	M (15)	3	20.0	2	13.3	9	60.0	1	6.7
	Totals (173)	39	22.5	63	36.4	59	34.1	12	6.9
Effects of Feedback	R (78)	30	38.5	34	43.6	12	15.4	2	2.6
	T (21)	7	33.3	12	57.7	2	9.5	0	0.0
	B (59)	24	40.7	30	50.8	5	8.5	0	0.0
	M (15)	4	26.7	5	33.3	6	40.0	0	0.0
	Totals (173)	65	37.6	81	46.8	25	14.5	2	1.2
Equivalent Circuits	R (78)	30	38.5	28	35.9	19	24.4	1	1.3
	T (21)	7	33.3	8	38.1	6	28.6	0	0.0
	B (59)	18	30.5	27	45.8	11	18.6	3	5.1
	M (15)	3	20.0	7	46.7	4	26.7	1	6.7
	Totals (173)	58	33.5	70	40.5	40	23.1	5	2.9
Transistor Measurements	R (78)	30	38.5	37	47.4	11	14.1	0	0.0
	T (21)	7	33.3	10	47.6	4	19.0	0	0.0
	B (59)	31	52.5	22	37.2	5	8.5	1	1.7
	M (15)	4	26.7	7	46.7	3	20.0	1	6.7
	Totals (173)	72	41.6	76	43.9	23	13.3	2	1.2

TABLE 11--Continued

Units		Taught in Depth No.	Taught in Depth %	Empha-sized No.	Empha-sized %	Discussed Briefly No.	Discussed Briefly %	Not Taught No.	Not Taught %
Troubleshooting Procedures	R (78)	46	59.0	20	25.6	11	14.1	1	1.3
	T (21)	13	61.9	6	28.6	2	9.5	0	0.0
	B (59)	39	66.1	14	23.7	4	6.8	2	3.4
	M (15)	7	46.7	8	53.3	0	0.0	0	0.0
	Totals (173)	105	60.7	48	27.7	17	9.8	3	1.7
Transistor Amplifiers and Circuits:									
Common Emitter, Collector, and Base Configurations	R (78)	40	51.3	30	38.5	6	7.7	2	2.6
	T (21)	7	33.3	9	42.9	4	19.0	1	4.8
	B (59)	38	64.4	19	32.2	2	3.4	0	0.0
	M (15)	7	46.7	7	46.7	1	6.7	0	0.0
	Totals (173)	92	53.2	65	37.6	13	7.5	3	1.7
Push-Pull Amplifiers	R (78)	23	29.5	40	51.3	12	15.4	3	3.8
	T (21)	7	33.3	8	38.1	6	28.6	0	0.0
	B (59)	30	50.8	26	44.1	3	5.1	0	0.0
	M (15)	4	26.7	8	53.3	3	20.0	0	0.0
	Totals (173)	64	37.0	82	47.4	24	13.9	3	1.7
Cascade Audio Amplifiers	R (78)	20	25.6	38	48.7	17	21.8	3	3.8
	T (21)	6	28.6	10	47.6	5	23.8	0	0.0
	B (59)	27	45.8	28	47.5	4	6.8	0	0.0
	M (15)	4	26.7	6	40.0	5	33.3	0	0.0
	Totals (173)	57	32.9	82	47.4	31	17.9	3	1.7

TABLE 11--Continued

Units		Taught in Depth No.	Taught in Depth %	Emphasized No.	Emphasized %	Discussed Briefly No.	Discussed Briefly %	Not Taught No.	Not Taught %
R-C Coupled Audio Amplifiers	R (78)	20	25.6	38	48.7	17	21.8	3	3.8
	T (21)	6	28.6	11	52.4	4	19.0	0	0.0
	B (59)	28	47.5	25	42.3	6	10.1	0	0.0
	M (15)	4	26.7	7	46.7	4	26.7	0	0.0
	Totals (173)	58	33.5	81	46.8	31	17.9	3	1.7
Transformer Coupled Amplifiers	R (78)	19	24.4	36	46.2	20	25.6	3	3.8
	T (21)	6	28.6	12	57.1	3	14.3	0	0.0
	B (59)	24	40.7	27	45.8	8	13.6	0	0.0
	M (15)	4	26.7	7	46.7	4	26.7	0	0.0
	Totals (173)	53	30.6	82	47.4	35	20.2	3	1.7
Direct Coupled Amplifiers	R (78)	27	34.6	32	41.0	17	21.8	2	2.6
	T (21)	6	28.6	10	47.6	5	23.8	0	0.0
	B (59)	28	47.5	25	42.3	6	10.1	0	0.0
	M (15)	4	26.7	8	53.3	3	20.0	0	0.0
	Totals (173)	65	37.6	75	43.4	31	17.9	2	1.2
Power Amplifiers	R (78)	23	29.5	42	53.8	11	14.1	2	2.6
	T (21)	6	28.6	13	61.9	2	9.5	0	0.0
	B (59)	28	47.5	29	49.2	2	3.4	0	0.0
	M (15)	4	26.7	8	53.3	3	20.0	0	0.0
	Totals (173)	61	35.3	92	53.2	18	10.4	2	1.2

TABLE 11--Continued

Units		Taught in Depth No.	Taught in Depth %	Emphasized No.	Emphasized %	Discussed Briefly No.	Discussed Briefly %	Not Taught No.	Not Taught %
Tuned Amplifiers	R (78)	18	23.1	39	50.0	17	21.8	4	5.1
	T (21)	6	28.6	10	47.6	5	28.3	0	0.0
	B (59)	27	45.8	27	45.8	5	8.5	0	0.0
	M (15)	4	26.7	7	46.7	4	26.7	0	0.0
	Totals (173)	55	31.8	83	48.0	31	17.9	4	2.3
Reflex Amplifiers	R (78)	14	17.9	34	43.6	23	29.5	7	9.0
	T (21)	6	28.6	8	38.1	6	28.6	1	4.8
	B (59)	19	32.2	26	44.1	12	20.3	2	3.4
	M (15)	4	26.7	4	26.7	7	46.7	0	0.0
	Totals (173)	43	24.9	72	41.6	48	27.7	10	5.8
D-C Amplifiers	R (78)	31	39.7	36	46.2	9	11.5	2	2.6
	T (21)	6	28.6	11	52.4	4	19.0	0	0.0
	B (59)	25	42.3	27	45.8	6	10.1	1	1.7
	M (15)	5	33.3	7	46.7	3	20.0	0	0.0
	Totals (173)	67	38.7	81	46.8	22	12.7	3	1.7
R-F and I-F Amplifiers	R (78)	18	23.1	33	42.3	22	28.2	5	6.4
	T (21)	6	28.6	9	42.9	6	28.6	0	0.0
	B (59)	28	47.5	25	42.3	6	10.1	0	0.0
	M (15)	3	20.0	8	53.3	4	26.7	0	0.0
	Totals (173)	55	31.8	75	43.4	38	22.0	5	2.9

TABLE 11--Continued

Units		Taught in Depth No.	Taught in Depth %	Empha-sized No.	Empha-sized %	Discussed Briefly No.	Discussed Briefly %	Not Taught No.	Not Taught %
Wide-Band Amplifiers	R (78)	18	23.1	38	48.7	20	25.6	2	2.6
	T (21)	6	28.6	12	57.1	3	14.3	0	0.0
	B (59)	29	49.2	26	44.1	3	5.1	1	1.7
	M (15)	4	26.7	6	40.0	5	33.3	0	0.0
	Totals (173)	57	32.9	82	47.4	31	17.9	3	1.7
Preamplifiers	R (78)	18	23.1	37	47.4	18	23.1	5	6.4
	T (21)	6	28.6	10	47.6	5	23.8	0	0.0
	B (59)	32	54.2	20	33.9	7	11.9	0	0.0
	M (15)	4	26.7	6	40.0	5	33.3	0	0.0
	Totals (173)	60	34.7	73	42.2	35	20.2	5	2.9
Phase Inverters	R (78)	16	20.5	37	47.4	22	28.2	3	3.8
	T (21)	5	23.8	10	47.6	4	19.0	2	9.5
	B (59)	24	40.7	27	45.8	8	13.6	0	0.0
	M (15)	4	26.7	5	33.3	5	33.3	1	6.7
	Totals (173)	49	28.3	79	45.7	39	22.5	6	3.5
Bridge Arrangements	R (78)	17	21.8	34	43.6	23	29.5	4	5.1
	T (21)	6	28.6	13	61.9	2	9.5	0	0.0
	B (59)	19	32.2	32	54.2	8	13.6	0	0.0
	M (15)	4	26.7	6	40.0	4	26.7	1	6.7
	Totals (173)	46	26.6	85	49.1	37	21.4	5	2.9

TABLE 11--Continued

Units		Taught in Depth No.	Taught in Depth %	Emphasized No.	Emphasized %	Discussed Briefly No.	Discussed Briefly %	Not Taught No.	Not Taught %
Symmetry Circuits	R (78)	19	24.4	31	39.7	24	30.8	4	5.1
	T (21)	3	14.3	12	57.1	5	23.8	1	4.8
	B (59)	21	35.6	32	54.2	4	6.8	2	3.4
	M (15)	4	26.7	4	26.7	6	40.0	1	6.7
	Totals (173)	47	27.2	79	45.7	39	22.5	8	4.6
Transistor Current Regulators	R (78)	29	37.2	37	47.4	9	11.5	3	3.8
	T (21)	6	28.6	13	61.9	2	9.5	0	0.0
	B (59)	24	40.7	31	52.5	4	6.8	0	0.0
	M (15)	4	26.7	8	53.3	3	20.0	0	0.0
	Totals (173)	63	36.4	89	51.4	18	10.4	3	1.7
Transistor Voltage Regulators	R (78)	32	41.0	34	43.6	10	12.8	2	2.6
	T (21)	7	33.3	13	61.9	1	4.8	0	0.0
	B (59)	25	42.3	31	52.5	3	5.1	0	0.0
	M (15)	4	26.7	9	60.0	2	13.3	0	0.0
	Totals (173)	68	39.3	87	50.3	16	9.2	2	1.2
Bias Circuits	R (78)	33	42.3	31	39.7	11	14.1	3	3.8
	T (21)	4	19.0	14	66.7	3	14.3	0	0.0
	B (59)	28	47.5	28	47.5	3	5.1	0	0.0
	M (15)	5	33.3	8	53.3	2	13.3	0	0.0
	Totals (173)	70	40.5	81	46.8	19	11.0	3	1.7

TABLE 11--Continued

Units		Taught in Depth No.	Taught in Depth %	Emphasized No.	Emphasized %	Discussed Briefly No.	Discussed Briefly %	Not Taught No.	Not Taught %
Printed Circuits	R (78)	30	38.5	30	38.5	17	21.8	1	1.3
	T (21)	7	33.3	9	42.9	4	19.0	1	4.8
	B (59)	32	54.2	22	37.2	3	5.1	2	3.4
	M (15)	5	33.3	7	46.7	2	13.3	1	6.7
	Totals (173)	74	42.8	68	39.3	26	15.0	5	2.9
Transistor Receivers: Power Supplies	R (78)	22	28.2	34	43.6	20	25.6	2	2.6
	T (21)	7	33.3	11	52.4	3	14.3	0	0.0
	B (59)	24	40.7	28	47.5	6	10.1	1	1.7
	M (15)	4	26.7	6	40.0	5	33.3	0	0.0
	Totals (173)	57	32.9	79	45.7	34	19.7	3	1.7
Oscillators	R (78)	20	25.6	37	47.4	18	23.1	3	3.8
	T (21)	7	33.3	11	52.4	3	14.3	0	0.0
	B (59)	23	39.0	29	49.2	6	10.1	1	1.7
	M (15)	4	26.7	7	46.7	4	26.7	0	0.0
	Totals (173)	54	31.2	84	48.6	31	17.9	4	2.3
Modulation, Mixing and Detection Circuits	R (78)	18	23.1	35	44.9	21	26.9	4	5.1
	T (21)	7	33.3	11	52.4	2	9.5	1	4.8
	B (59)	24	40.7	30	50.8	5	8.5	0	0.0
	M (15)	3	20.0	8	53.3	4	26.7	0	0.0
	Totals (173)	52	30.1	84	48.6	32	18.5	5	2.9

TABLE 11--Continued

Units		Taught in Depth No.	Taught in Depth %	Emphasized No.	Emphasized %	Discussed Briefly No.	Discussed Briefly %	Not Taught No.	Not Taught %
AGC Circuits	R (78)	13	16.7	34	43.6	23	29.5	8	10.3
	T (21)	6	28.6	10	47.6	4	19.0	1	4.8
	B (59)	19	32.2	31	52.5	8	13.6	1	1.7
	M (15)	3	20.0	4	26.7	7	46.7	1	6.7
	Totals (173)	41	23.7	79	45.7	42	24.3	11	6.4
ADVANCED CIRCUITS AND SYSTEMS									
Nonsinusoidal Waveshapes:									
Square Waves	R (78)	17	21.8	37	47.4	20	25.6	4	5.1
	T (21)	1	4.8	6	28.6	14	66.7	0	0.0
	B (59)	16	27.1	31	52.5	12	20.3	0	0.0
	M (15)	4	26.7	5	33.3	6	40.0	0	0.0
	Totals (173)	38	22.0	79	45.7	52	30.1	4	2.3
Rectangular Waves	R (78)	14	17.9	38	48.7	22	28.2	4	5.1
	T (21)	0	0.0	6	28.6	15	71.4	0	0.0
	B (59)	14	23.7	31	52.5	13	22.0	1	1.7
	M (15)	3	20.0	6	40.0	6	40.0	0	0.0
	Totals (173)	31	17.9	81	46.8	56	32.4	5	2.9
Sawtooth Waves	R (78)	13	16.7	40	51.3	20	25.6	5	6.4
	T (21)	1	4.8	6	28.6	14	66.7	0	0.0
	B (59)	18	30.5	30	50.8	10	16.9	1	1.7
	M (15)	1	6.7	6	40.0	8	53.3	0	0.0
	Totals (173)	33	19.1	82	47.4	52	30.1	6	3.5

TABLE 11--Continued

Units		Taught in Depth No.	Taught in Depth %	Empha-sized No.	Empha-sized %	Discussed Briefly No.	Discussed Briefly %	Not Taught No.	Not Taught %
Triangular and Peaked Waves	R (78)	11	14.1	41	52.6	20	25.6	6	7.7
	T (21)	1	4.8	6	28.6	14	66.7	0	0.0
	B (59)	15	25.4	30	50.8	12	20.3	2	3.4
	M (15)	1	6.7	6	40.0	8	53.3	0	0.0
	Totals (173)	28	16.2	83	48.0	54	31.2	8	4.6
Multi-Segmented Waves	R (78)	9	11.5	33	42.3	28	35.9	8	10.3
	T (21)	0	0.0	6	28.6	15	71.4	0	0.0
	B (59)	13	22.0	29	49.2	14	23.7	3	5.1
	M (15)	1	6.7	5	33.3	9	60.0	0	0.0
	Totals (173)	23	13.3	73	42.2	66	38.2	11	6.4
Curved Wave Forms	R (78)	10	12.8	35	44.9	25	32.1	8	10.3
	T (21)	1	4.8	5	23.8	15	71.4	0	0.0
	B (59)	14	23.7	30	50.8	13	22.0	2	3.4
	M (15)	0	0.0	7	46.7	7	46.7	1	6.7
	Totals (173)	25	14.5	77	44.5	60	34.7	11	6.4
Transients	R (78)	24	30.8	36	46.2	14	17.9	4	5.1
	T (21)	2	9.5	6	28.6	13	61.9	0	0.0
	B (59)	15	25.4	31	52.5	13	22.0	0	0.0
	M (15)	3	20.0	5	33.3	7	46.7	0	0.0
	Totals (173)	44	25.4	78	45.1	47	27.2	4	2.3

TABLE 11--Continued

Units		Taught in Depth		Empha-sized		Discussed Briefly		Not Taught	
		No.	%	No.	%	No.	%	No.	%
D-C Components of Waveforms	R (78)	19	24.4	35	44.9	20	25.6	4	5.1
	T (21)	1	4.8	8	38.1	12	57.1	0	0.0
	B (59)	16	27.1	31	52.5	12	20.3	0	0.0
	M (15)	3	20.0	5	33.3	7	46.7	0	0.0
	Totals (173)	39	22.5	79	45.7	51	29.5	4	2.3
A-C Components of Waveforms	R (78)	19	24.4	35	44.9	20	25.6	4	5.1
	T (21)	1	4.8	8	38.1	12	57.1	0	0.0
	B (59)	18	30.5	29	49.2	12	20.3	0	0.0
	M (15)	3	20.0	5	33.3	7	46.7	0	0.0
	Totals (173)	41	23.7	77	44.5	51	29.5	4	2.3
Waveform Generation	R (78)	18	23.1	30	38.5	25	32.1	5	6.4
	T (21)	0	0.0	9	42.9	12	57.1	0	0.0
	B (59)	19	32.2	29	49.2	11	18.6	0	0.0
	M (15)	2	13.3	6	40.0	7	46.7	0	0.0
	Totals (173)	39	22.5	74	42.8	55	31.8	5	2.9
Pulse and Switching Circuits:									
Diode and Triode Switching Circuits	R (78)	22	28.2	31	39.7	17	21.8	8	10.3
	T (21)	6	28.6	8	38.1	6	28.6	1	4.8
	B (59)	24	40.7	27	45.8	5	8.5	3	5.1
	M (15)	2	13.3	6	40.0	5	33.3	2	13.3
	Totals (173)	54	31.2	72	41.6	33	19.1	14	8.1

TABLE 11--Continued

Units		Taught in Depth No.	Taught in Depth %	Emphasized No.	Emphasized %	Discussed Briefly No.	Discussed Briefly %	Not Taught No.	Not Taught %
Free Running Multivibrators	R (78)	23	29.5	34	43.6	18	23.1	3	3.8
	T (21)	3	14.3	8	38.1	8	38.1	2	9.5
	B (59)	20	33.9	32	54.2	7	11.9	0	0.0
	M (15)	5	33.3	5	33.3	5	33.3	0	0.0
	Totals (173)	51	29.5	79	45.7	38	22.0	5	2.9
Bistable Multivibrators	R (78)	25	32.1	33	42.3	17	21.8	3	3.8
	T (21)	2	9.5	8	38.1	8	38.1	3	14.3
	B (59)	19	32.2	31	52.5	7	11.9	2	3.4
	M (15)	6	40.0	5	33.3	4	26.7	0	0.0
	Totals (173)	52	30.1	77	44.5	36	20.8	8	4.6
Monostable Multivibrators	R (78)	26	33.3	31	39.7	18	23.1	3	3.8
	T (21)	2	9.5	8	38.1	9	42.9	2	9.5
	B (59)	17	28.8	33	55.9	7	11.9	2	3.4
	M (15)	5	33.3	6	40.0	4	26.7	0	0.0
	Totals (173)	50	28.9	78	45.1	38	22.0	7	4.0
Astable Multivibrators	R (78)	23	29.5	33	42.3	18	23.1	4	5.1
	T (21)	2	9.5	6	28.6	11	52.4	2	9.5
	B (59)	18	30.5	31	52.5	8	13.6	2	3.4
	M (15)	5	33.3	6	40.0	4	26.7	0	0.0
	Totals (173)	48	27.7	76	43.9	41	23.7	8	4.6

TABLE 11--Continued

Units		Taught in Depth No.	Taught in Depth %	Emphasized No.	Emphasized %	Discussed Briefly No.	Discussed Briefly %	Not Taught No.	Not Taught %
Blocking Oscillators	R (78)	17	21.8	33	42.3	24	30.8	4	5.1
	T (21)	3	14.3	8	38.1	9	42.9	1	4.8
	B (59)	13	22.0	35	59.3	11	18.6	0	0.0
	M (15)	4	26.7	5	33.3	5	33.3	1	6.7
	Totals (173)	37	21.4	81	46.8	49	28.3	6	3.5
Shock-Excited Oscillators	R (78)	14	17.9	25	32.1	32	41.0	7	9.0
	T (21)	3	14.3	7	33.3	9	42.9	2	9.5
	B (59)	13	22.0	29	49.2	13	22.0	4	6.8
	M (15)	3	20.0	3	20.0	7	46.7	2	13.3
	Totals (173)	33	19.1	64	37.0	61	35.3	15	8.7
Gas-Tube Relaxation Oscillators	R (78)	7	9.0	22	28.2	37	47.4	12	15.4
	T (21)	4	19.0	5	23.8	10	47.6	2	9.5
	B (59)	9	15.3	25	42.3	22	37.2	3	5.1
	M (15)	3	20.0	2	13.3	7	46.7	3	20.0
	Totals (173)	23	13.3	54	31.2	76	43.9	20	11.6
Gating Circuits	R (78)	29	37.2	30	38.5	15	19.2	4	5.1
	T (21)	4	19.0	9	42.9	7	33.3	1	4.8
	B (59)	24	40.7	28	47.5	6	10.1	1	1.7
	M (15)	5	33.3	6	40.0	4	26.7	0	0.0
	Totals (173)	62	35.8	73	42.2	32	18.5	6	3.5

TABLE 11--Continued

Units		Taught in Depth No.	Taught in Depth %	Emphasized No.	Emphasized %	Discussed Briefly No.	Discussed Briefly %	Not Taught No.	Not Taught %
Delay Circuits	R (78)	26	33.3	29	37.2	20	25.6	3	3.8
	T (21)	4	19.0	8	38.1	8	38.1	1	4.8
	B (59)	18	30.5	32	54.2	9	15.3	0	0.0
	M (15)	4	26.7	7	46.7	4	26.7	0	0.0
	Totals (173)	52	30.1	76	43.9	41	23.7	4	2.3
Saturable-Core Reactor Circuits	R (78)	10	12.8	26	33.3	30	38.5	12	15.4
	T (21)	3	14.3	9	42.9	8	38.1	1	4.8
	B (59)	7	11.9	33	55.9	16	27.1	3	5.1
	M (15)	3	20.0	6	40.0	6	40.0	0	0.0
	Totals (173)	23	13.3	74	42.8	60	34.7	16	9.2
Pulse Generators	R (78)	18	23.1	35	44.9	21	26.9	4	5.1
	T (21)	4	19.0	7	33.3	10	47.6	0	0.0
	B (59)	20	33.9	31	52.5	7	11.9	1	1.7
	M (15)	1	6.7	7	46.7	7	46.7	0	0.0
	Totals (173)	43	24.9	80	46.2	45	26.0	5	2.9
Triggering Circuits	R (78)	23	29.5	33	42.3	19	24.4	3	3.8
	T (21)	4	19.0	8	38.1	9	42.9	0	0.0
	B (59)	21	35.6	30	50.8	6	10.1	2	3.4
	M (15)	3	20.0	7	46.7	5	33.3	0	0.0
	Totals (173)	51	29.5	78	45.1	39	22.5	5	2.9

TABLE 11--Continued

Units		Taught in Depth No.	Taught in Depth %	Emphasized No.	Emphasized %	Discussed Briefly No.	Discussed Briefly %	Not Taught No.	Not Taught %
Pulse Counters	R (78)	29	37.2	30	38.5	14	17.9	5	6.4
	T (21)	5	23.8	8	38.1	8	38.1	0	0.0
	B (59)	22	37.2	31	52.5	5	8.5	1	1.7
	M (15)	2	13.3	8	53.3	5	33.3	0	0.0
	Totals (173)	58	33.5	77	44.5	32	18.5	6	3.5
Logic Circuits	R (78)	39	50.0	24	30.8	11	14.1	4	5.1
	T (21)	5	23.8	7	33.3	9	42.9	0	0.0
	B (59)	30	50.8	24	40.7	3	5.1	2	3.4
	M (15)	3	20.0	8	53.3	4	26.7	0	0.0
	Totals (173)	77	44.5	63	36.4	27	15.6	6	3.5
Pulse Amplifiers	R (78)	29	37.2	30	38.5	16	20.5	3	3.8
	T (21)	3	14.3	8	38.1	10	47.6	0	0.0
	B (59)	18	30.5	34	57.6	6	10.1	1	1.7
	M (15)	2	13.3	6	40.0	7	46.7	0	0.0
	Totals (173)	52	30.1	78	45.1	39	22.5	4	2.3
Linear Wave Shaping	R (78)	19	24.4	27	34.6	26	33.3	6	7.7
	T (21)	2	9.5	9	42.9	9	42.9	1	4.8
	B (59)	18	30.5	32	54.2	7	11.9	2	3.4
	M (15)	3	20.0	6	40.0	6	40.0	0	0.0
	Totals (173)	42	24.3	74	42.8	48	27.7	9	5.2

TABLE 11--Continued

Units		Taught in Depth No.	%	Empha- sized No.	%	Discussed Briefly No.	%	Not Taught No.	%
Binary Systems	R (78)	38	48.7	26	33.3	11	14.1	3	3.8
	T (21)	4	19.0	8	38.1	9	42.9	0	0.0
	B (59)	27	45.8	27	45.8	4	6.8	1	1.7
	M (15)	4	26.7	7	46.7	4	26.7	0	0.0
	Totals (173)	73	42.2	68	39.3	28	16.2	4	2.3
Decimal Systems	R (78)	29	37.2	30	38.5	16	20.5	3	3.8
	T (21)	4	19.0	6	28.6	11	52.4	0	0.0
	B (59)	23	39.0	30	50.8	4	6.8	2	3.4
	M (15)	4	26.7	6	40.0	4	26.7	1	6.7
	Totals (173)	60	34.7	72	41.6	35	20.2	6	3.5
Null Detectors	R (78)	11	14.1	30	38.5	32	41.0	5	6.4
	T (21)	2	9.5	6	28.6	12	57.1	1	4.8
	B (59)	13	22.0	31	52.5	11	18.6	4	6.8
	M (15)	2	13.3	6	40.0	7	46.7	0	0.0
	Totals (173)	28	16.2	73	42.2	62	35.8	10	5.8
Digital Computer Fundamentals:									
Computer Applications	R (78)	19	24.4	31	39.7	22	28.2	6	7.7
	T (21)	3	14.3	9	42.9	9	42.9	0	0.0
	B (59)	26	44.1	22	37.2	6	10.1	5	8.5
	M (15)	4	26.7	6	40.0	5	33.3	0	0.0
	Totals (173)	52	30.1	68	39.3	42	24.3	11	6.4

TABLE 11--Continued

Units		Taught in Depth		Empha-sized		Discussed Briefly		Not Taught	
		No.	%	No.	%	No.	%	No.	%
Computer Programming	R (78)	9	11.5	33	42.3	29	37.2	7	9.0
	T (21)	4	19.0	9	42.9	7	33.3	1	4.8
	B (59)	28	47.5	19	32.2	7	11.9	5	8.5
	M (15)	4	26.7	6	40.0	5	33.3	0	0.0
	Totals (173)	45	26.0	67	38.7	48	27.7	13	7.5
Computer Math	R (78)	13	16.7	38	48.7	20	25.6	7	9.0
	T (21)	3	14.3	8	38.1	9	42.9	1	4.8
	B (59)	32	54.2	15	25.4	7	11.9	5	8.5
	M (15)	4	26.7	7	46.7	4	26.7	0	0.0
	Totals (173)	52	30.1	68	39.3	40	23.1	13	7.5
Adders and Sub-tractors	R (78)	14	17.9	35	44.9	20	25.6	9	11.5
	T (21)	3	14.3	7	33.3	10	47.6	1	4.8
	B (59)	23	39.0	24	40.7	7	11.9	5	8.5
	M (15)	3	20.0	6	40.0	6	40.0	0	0.0
	Totals (173)	43	24.9	72	41.6	43	24.9	15	8.7
Methods of Data Storage	R (78)	15	19.2	36	46.2	20	25.6	7	9.0
	T (21)	3	14.3	9	42.9	9	42.9	0	0.0
	B (59)	23	39.0	24	40.7	7	11.9	5	8.5
	M (15)	3	20.0	7	46.7	5	33.3	0	0.0
	Totals (173)	44	25.4	76	43.9	41	23.7	12	6.9

TABLE 11--Continued

Units		Taught in Depth No.	Taught in Depth %	Empha-sized No.	Empha-sized %	Discussed Briefly No.	Discussed Briefly %	Not Taught No.	Not Taught %
Analog-to-Digital Conversion	R (78)	25	32.1	35	44.9	10	12.8	8	10.3
	T (21)	3	14.3	7	33.3	11	52.4	0	0.0
	B (59)	28	47.5	21	35.6	5	8.5	5	8.5
	M (15)	1	6.7	9	60.0	5	33.3	0	0.0
	Totals (173)	57	32.9	72	41.6	31	17.9	13	7.5
Limiters, Clampers, Counters:									
Diode Limiters	R (78)	10	12.8	32	41.0	32	41.0	4	5.1
	T (21)	2	9.5	9	42.9	9	42.9	1	4.8
	B (59)	15	25.4	31	52.5	12	20.3	1	1.7
	M (15)	1	6.7	6	40.0	8	53.3	0	0.0
	Totals (173)	28	16.2	78	45.1	61	35.3	6	3.5
Triode Limiters	R (78)	8	10.3	29	37.2	37	47.5	4	5.1
	T (21)	2	9.5	9	42.9	9	42.9	1	4.8
	B (59)	13	22.0	32	54.2	13	22.0	1	1.7
	M (15)	0	0.0	3	20.0	12	80.0	0	0.0
	Totals (173)	23	13.3	73	42.2	71	41.0	6	3.5
Diode Clamping	R (78)	10	12.8	33	42.3	30	38.5	5	6.4
	T (21)	2	9.5	9	42.9	9	42.9	1	4.8
	B (59)	15	25.4	32	54.2	11	18.6	1	1.7
	M (15)	1	6.7	5	33.3	8	53.3	1	6.7
	Totals (173)	28	16.2	79	45.7	58	33.5	8	4.6

TABLE 11--Continued

Units		Taught in Depth No.	Taught in Depth %	Emphasized No.	Emphasized %	Discussed Briefly No.	Discussed Briefly %	Not Taught No.	Not Taught %
Counters (Frequency Divider)	R (78)	15	19.2	41	52.6	19	24.4	3	3.8
	T (21)	1	4.8	11	52.4	8	38.1	1	4.8
	B (59)	23	39.0	27	45.8	8	13.6	1	1.7
	M (15)	1	6.7	6	40.0	7	46.7	1	6.7
	Totals (173)	40	23.1	85	49.1	42	24.3	6	3.5
Diode Clippers	R (78)	13	16.7	29	37.2	30	38.5	6	7.7
	T (21)	0	0.0	10	47.6	10	47.6	1	4.8
	B (59)	14	23.7	32	54.2	11	18.6	2	3.4
	M (15)	0	0.0	6	40.0	8	53.3	1	6.7
	Totals (173)	27	15.6	77	44.5	59	34.1	10	5.8
Sweep-Generator Circuits:									
Sawtooth-Wave Form Circuits	R (78)	7	9.0	29	37.2	32	41.0	10	12.8
	T (21)	2	9.5	9	42.9	7	33.3	3	14.3
	B (59)	14	23.7	28	47.5	13	22.0	4	6.8
	M (15)	1	6.7	2	13.3	12	80.0	0	0.0
	Totals (173)	24	13.9	68	39.3	64	37.0	17	9.8
Gas-Tube Sweep Generator Circuits	R (78)	3	3.8	15	19.2	45	57.7	15	19.2
	T (21)	2	9.5	7	33.3	9	42.9	3	14.3
	B (59)	3	5.1	23	39.0	29	49.2	4	6.8
	M (15)	0	0.0	2	13.3	13	86.7	0	0.0
	Totals (173)	8	4.6	47	27.2	96	55.5	22	12.7

TABLE 11--Continued

Units		Taught in Depth No.	Taught in Depth %	Emphasized No.	Emphasized %	Discussed Briefly No.	Discussed Briefly %	Not Taught No.	Not Taught %
Vacuum-Tube Sweep Generator Circuits	R (78)	3	3.8	15	19.2	48	61.5	12	15.4
	T (21)	2	9.5	7	33.3	10	47.6	2	9.5
	B (59)	4	6.8	25	42.3	28	47.5	2	3.4
	M (15)	0	0.0	2	13.3	11	73.3	2	13.3
	Totals (173)	9	5.2	49	28.3	97	56.1	18	10.4
Transistor Sweep Generator Circuits	R (78)	7	9.0	32	41.0	34	43.6	5	6.4
	T (21)	4	19.0	6	28.6	9	42.9	2	9.5
	B (59)	20	33.9	28	47.5	9	15.3	2	3.4
	M (15)	2	13.3	2	13.3	11	73.3	0	0.0
	Totals (173)	33	19.1	68	39.3	63	36.4	9	5.2
Sweep Expansion and Delay Circuits	R (78)	6	7.7	29	37.2	33	42.3	10	12.8
	T (21)	2	9.5	8	38.1	9	42.9	2	9.5
	B (59)	16	27.1	26	44.1	14	23.7	3	5.1
	M (15)	1	6.7	3	20.0	11	73.3	0	0.0
	Totals (173)	25	14.5	66	38.2	67	38.7	15	8.7
TV Transmitters and Receivers:									
Frequency Bands	R (78)	4	5.1	14	17.9	42	53.8	18	23.1
	T (21)	2	9.5	8	38.1	8	38.1	3	14.3
	B (59)	12	20.3	31	52.5	14	23.7	2	3.4
	M (15)	4	26.7	1	6.7	9	60.0	1	6.7
	Totals (173)	22	12.7	54	31.2	73	42.2	24	13.9

TABLE 11--Continued

Units		Taught in Depth No.	Taught in Depth %	Empha-sized No.	Empha-sized %	Discussed Briefly No.	Discussed Briefly %	Not Taught No.	Not Taught %
Standard Interlaced Scanning	R (78)	5	6.4	16	20.5	40	51.3	17	21.8
	T (21)	2	9.5	6	28.6	9	42.9	4	19.0
	B (59)	18	30.5	34	57.6	6	10.1	1	1.7
	M (15)	3	20.0	2	13.3	8	53.3	2	13.3
	Totals (173)	28	16.2	58	33.5	63	36.4	24	13.9
Composite TV Picture Signal	R (78)	6	7.7	16	20.5	39	50.0	17	21.8
	T (21)	2	9.5	8	38.1	8	38.1	3	14.3
	B (59)	23	39.0	32	54.2	3	5.1	1	1.7
	M (15)	3	20.0	2	13.3	8	53.3	2	13.3
	Totals (173)	34	19.7	58	33.5	58	33.5	23	13.3
Camera Tubes	R (78)	4	5.1	15	19.2	40	51.3	19	24.4
	T (21)	2	9.5	7	33.3	9	42.9	3	14.3
	B (59)	18	30.5	32	54.2	8	13.6	1	1.7
	M (15)	2	13.3	2	13.3	9	60.0	2	13.3
	Totals (173)	26	15.0	56	32.4	66	38.2	25	14.5
TV Image and Image Resolution	R (78)	6	7.7	16	20.5	38	48.7	18	23.1
	T (21)	1	4.8	8	38.1	9	42.9	3	14.3
	B (59)	22	37.2	31	52.5	5	8.5	1	1.7
	M (15)	2	13.3	2	13.3	9	60.0	2	13.3
	Totals (173)	31	17.9	57	32.9	61	35.3	24	13.9

TABLE 11--Continued

Units		Taught in Depth		Empha-sized		Discussed Briefly		Not Taught	
		No.	%	No.	%	No.	%	No.	%
TV Transmitter Functional Analysis	R (78)	4	5.1	15	19.2	40	51.3	19	24.4
	T (21)	3	14.3	6	28.6	8	38.1	4	19.0
	B (59)	29	49.2	23	39.0	6	10.1	1	1.7
	M (15)	3	20.0	2	13.3	8	53.3	2	13.3
Totals	(173)	39	22.5	46	26.6	62	35.8	26	15.0
TV Receiver Functional Analysis	R (78)	8	10.3	16	20.5	35	44.9	19	24.4
	T (21)	3	14.3	6	28.6	9	42.9	3	14.3
	B (59)	19	32.2	27	45.8	11	18.6	2	3.4
	M (15)	2	13.3	3	20.0	8	53.3	2	13.3
Totals	(173)	32	18.5	52	30.1	63	36.4	26	15.0
MICROWAVE ELECTRONICS									
Microwave Transmission:									
Communications Transmitters	R (78)	7	9.0	21	26.9	30	38.5	20	25.6
	T (21)	10	47.6	6	28.6	4	19.0	1	4.8
	B (59)	22	37.2	30	50.8	6	10.1	1	1.7
	M (15)	3	20.0	5	33.3	6	40.1	1	6.7
Totals	(173)	42	24.3	62	35.8	46	26.6	23	13.3
Radar Transmitters	R (78)	9	11.5	16	20.5	32	41.0	21	26.9
	T (21)	5	23.8	8	38.1	7	33.3	1	4.8
	B (59)	15	25.4	31	52.5	11	18.6	2	3.4
	M (15)	3	20.0	5	33.3	5	33.3	2	13.3
Totals	(173)	32	18.5	60	34.7	55	31.8	26	15.0

TABLE 11--Continued

Units		Taught in Depth No.	Taught in Depth %	Emphasized No.	Emphasized %	Discussed Briefly No.	Discussed Briefly %	Not Taught No.	Not Taught %
Generating Microwave Signals	R (78)	11	14.1	20	25.6	25	32.1	22	28.2
	T (21)	7	33.3	9	42.9	4	19.0	1	4.8
	B (59)	20	33.9	32	54.2	6	10.1	1	1.7
	M (15)	2	13.3	5	33.3	6	40.0	2	13.3
	Totals (173)	40	23.1	66	38.2	41	23.7	26	15.0
Cavity Resonators	R (78)	7	9.0	21	26.9	26	33.3	24	30.8
	T (21)	5	23.8	10	47.6	5	23.8	1	4.8
	B (59)	19	32.2	34	57.6	5	8.5	1	1.7
	M (15)	2	13.3	5	33.3	6	40.0	2	13.3
	Totals (173)	33	19.1	70	40.5	42	24.3	28	16.2
Waveguides	R (78)	9	11.5	21	26.9	25	32.1	23	29.5
	T (21)	5	23.8	11	52.4	4	19.0	1	4.8
	B (59)	19	32.2	30	50.8	9	15.3	1	1.7
	M (15)	2	13.3	5	33.3	6	40.0	2	13.3
	Totals (173)	35	20.2	67	38.7	44	25.4	27	15.6
Duplexers	R (78)	7	9.0	19	24.4	27	34.6	25	32.1
	T (21)	5	23.8	12	57.1	3	14.3	1	6.7
	B (59)	17	28.8	31	52.5	10	16.9	1	1.7
	M (15)	2	13.3	5	33.3	6	40.0	2	13.3
	Totals (173)	31	17.9	67	38.7	46	26.6	29	16.8

TABLE 11--Continued

Units		Taught in Depth No.	Taught in Depth %	Empha-sized No.	Empha-sized %	Discussed Briefly No.	Discussed Briefly %	Not Taught No.	Not Taught %
Microwave Antennas	R (78)	9	11.5	18	23.1	26	33.3	25	32.1
	T (21)	5	23.8	11	52.4	4	19.0	1	4.8
	B (59)	17	28.8	32	54.2	9	15.3	1	1.7
	M (15)	2	13.3	6	40.0	5	33.3	2	13.3
	Totals (173)	33	19.1	67	38.7	44	25.4	29	16.8
Transmission Lines	R (78)	10	12.8	20	25.7	25	32.1	23	29.5
	T (21)	5	23.8	11	52.4	4	19.0	1	4.8
	B (59)	19	32.2	31	52.5	8	13.6	1	1.7
	M (15)	2	13.3	6	40.0	5	33.3	2	13.3
	Totals (173)	36	20.8	68	39.3	42	24.3	27	15.6
Wavelength Measurement	R (78)	7	9.0	22	28.2	25	32.1	24	30.8
	T (21)	6	28.6	8	38.1	5	23.8	2	9.5
	B (59)	13	22.0	30	50.8	15	25.4	1	1.7
	M (15)	2	13.3	4	26.7	7	46.7	2	13.3
	Totals (173)	28	16.2	64	37.0	52	30.1	29	16.8
Special Amplifiers:									
Grounded-Grid Amplifiers	R (78)	4	5.1	18	23.1	34	43.6	22	28.2
	T (21)	3	14.3	8	38.1	8	38.1	2	9.5
	B (59)	16	27.1	27	45.8	15	25.4	1	1.7
	M (15)	1	6.7	4	26.7	8	53.3	2	13.3
	Totals (173)	24	13.9	57	32.9	65	37.6	27	15.6

TABLE 11--Continued

Units		Taught in Depth No.	Taught in Depth %	Emphasized No.	Emphasized %	Discussed Briefly No.	Discussed Briefly %	Not Taught No.	Not Taught %
Video Amplifiers	R (78)	9	11.5	23	29.5	34	43.6	12	15.4
	T (21)	7	33.3	7	33.3	5	23.8	2	9.5
	B (59)	25	42.3	30	50.8	3	5.1	1	1.7
	M (15)	1	6.7	7	46.7	7	46.7	0	0.0
	Totals (173)	42	24.3	67	38.7	49	28.3	15	8.7
D-C Amplifiers	R (78)	12	15.4	22	28.2	32	41.0	12	15.4
	T (21)	4	19.0	10	47.6	7	33.3	0	0.0
	B (59)	18	30.5	26	44.1	14	23.7	1	1.7
	M (15)	1	6.7	5	33.3	9	60.0	0	0.0
	Totals (173)	35	20.2	63	36.4	62	35.8	13	7.5
Traveling-Wave Amplifiers	R (78)	4	5.1	21	26.9	36	46.2	17	21.8
	T (21)	4	19.0	8	38.1	7	33.3	2	9.5
	B (59)	15	25.4	26	44.1	15	25.4	3	5.1
	M (15)	1	6.7	3	20.0	10	66.7	1	6.7
	Totals (173)	24	13.9	58	33.3	68	39.3	23	13.3
Parametric Amplifiers	R (78)	6	7.7	16	20.5	40	51.3	16	20.5
	T (21)	5	23.8	5	23.8	10	47.6	1	4.8
	B (59)	15	25.4	23	39.0	17	28.8	4	6.8
	M (15)	1	6.7	5	33.3	8	53.3	1	6.7
	Totals (173)	27	15.6	49	28.3	75	43.4	22	12.7

TABLE 11--Continued

Units		Taught in Depth No.	Taught in Depth %	Emphasized No.	Emphasized %	Discussed Briefly No.	Discussed Briefly %	Not Taught No.	Not Taught %
Masers	R (78)	8	10.3	19	24.4	34	43.6	17	21.8
	T (21)	3	14.3	10	47.6	7	33.3	1	4.8
	B (59)	21	35.6	21	35.6	12	20.3	5	8.5
	M (15)	2	13.3	3	20.0	10	66.7	0	0.0
	Totals (173)	34	19.7	53	30.6	63	36.4	23	13.3
Lasers	R (78)	11	14.1	20	25.6	32	41.0	15	19.2
	T (21)	5	23.8	7	33.3	6	28.6	3	14.3
	B (59)	23	39.0	21	35.6	10	16.9	5	8.5
	M (15)	2	13.3	2	13.3	10	66.7	1	6.7
	Totals (173)	41	23.7	50	28.9	58	33.5	24	13.9
Miscellaneous (Microwave):									
Backward-Wave Oscillators	R (78)	3	3.8	11	14.1	36	46.2	28	35.9
	T (21)	1	4.8	6	28.6	11	52.4	3	14.3
	B (59)	8	13.6	22	37.2	24	40.7	5	10.1
	M (15)	1	6.7	1	6.7	11	73.3	2	13.3
	Totals (173)	13	7.5	40	23.1	82	47.4	38	22.0
Microwave Mixers	R (78)	3	3.8	13	16.7	35	44.9	27	34.6
	T (21)	1	4.8	9	42.9	9	42.9	2	9.5
	B (59)	9	15.3	28	47.5	18	30.5	4	6.8
	M (15)	1	6.7	2	13.3	10	66.7	2	13.3
	Totals (173)	14	8.1	52	30.1	72	41.6	35	20.2

TABLE 11--<u>Continued</u>

Units		Taught in Depth		Emphasized		Discussed Briefly		Not Taught	
		No.	%	No.	%	No.	%	No.	%
Using Smith Chart	R (78)	5	6.4	14	17.9	32	41.0	27	34.6
	T (21)	1	4.8	4	19.0	12	57.1	4	19.0
	B (59)	8	13.6	25	42.3	19	32.2	7	11.9
	M (15)	1	6.7	4	26.7	8	53.3	2	13.3
	Totals (173)	15	8.7	47	27.2	71	41.0	40	23.1
Microwave Receivers:									
Communications Receiver	R (78)	4	5.1	19	24.4	32	41.0	23	29.5
	T (21)	9	42.9	8	38.1	3	14.3	1	4.8
	B (59)	14	23.7	32	54.2	11	18.6	2	3.4
	M (15)	1	6.7	5	33.3	7	46.7	2	13.3
	Totals (173)	28	16.2	64	37.0	53	30.6	28	16.2
Radar Receiver	R (78)	3	3.8	15	19.2	35	44.9	25	32.1
	T (21)	5	23.8	6	28.6	6	28.6	4	19.0
	B (59)	12	20.3	27	45.8	15	25.4	5	8.5
	M (15)	1	6.7	4	26.7	7	46.7	3	20.0
	Totals (173)	21	12.1	52	30.1	63	36.4	37	21.4
Multiplexing:									
Time-Division Multiplexing Principles	R (78)	9	11.5	23	29.5	37	47.4	9	11.5
	T (21)	5	23.8	7	33.3	8	38.1	1	4.8
	B (59)	15	25.4	25	42.3	18	30.5	1	1.7
	M (15)	5	33.3	3	20.0	6	40.0	1	6.7
	Totals (173)	34	19.7	58	33.5	69	39.9	12	6.9

TABLE 11--Continued

Units		Taught in Depth No.	Taught in Depth %	Emphasized No.	Emphasized %	Discussed Briefly No.	Discussed Briefly %	Not Taught No.	Not Taught %
Time-Division Multiplex Transmitter and Receiver Analysis	R (78)	7	9.0	21	26.9	35	44.9	15	19.2
	T (21)	5	23.8	8	38.1	7	33.3	1	4.8
	B (59)	14	23.7	27	45.8	16	27.1	2	3.4
	M (15)	4	26.7	3	20.0	6	40.0	2	13.3
	Totals (173)	30	17.3	59	34.1	64	37.0	20	11.6
Frequency-Division Multiplexing Principles	R (78)	7	9.0	23	29.5	36	46.2	12	15.4
	T (21)	4	19.0	8	38.1	8	38.1	1	4.8
	B (59)	12	20.3	29	49.2	16	27.1	2	3.4
	M (15)	4	26.7	4	26.7	6	40.0	1	6.7
	Totals (173)	27	15.6	64	37.0	66	38.2	16	9.2
Frequency-Division Multiplex Transmitter and Receiver Analysis	R (78)	6	7.7	20	25.6	37	47.4	15	19.2
	T (21)	4	19.0	8	38.1	7	33.3	2	9.5
	B (59)	12	20.3	29	49.2	16	27.1	2	3.4
	M (15)	4	26.7	3	20.0	6	40.0	2	13.3
	Totals (173)	26	15.0	60	34.7	66	38.2	21	12.1
Microwave Measurements:									
Attenuation Measurements	R (78)	4	5.1	18	23.1	33	42.3	23	29.5
	T (21)	9	42.9	6	28.6	4	19.0	2	9.5
	B (59)	11	18.6	26	44.1	21	35.6	1	1.7
	M (15)	2	13.3	4	26.7	7	46.7	2	13.3
	Totals (173)	26	15.0	54	31.2	65	37.6	28	16.2

TABLE 11--Continued

Units		Taught in Depth No.	Taught in Depth %	Emphasized No.	Emphasized %	Discussed Briefly No.	Discussed Briefly %	Not Taught No.	Not Taught %
Power Measurements	R (78)	4	5.1	19	24.4	31	39.7	24	30.8
	T (21)	9	42.9	7	33.3	3	14.3	2	9.5
	B (59)	10	16.9	29	49.2	19	32.2	1	1.7
	M (15)	1	6.7	6	40.0	6	40.0	2	13.3
	Totals (173)	24	13.9	61	35.3	59	34.1	29	16.8
Reflectometer Measurements	R (78)	3	3.8	19	24.4	30	38.5	26	33.3
	T (21)	8	38.1	7	33.3	4	19.0	2	9.5
	B (59)	9	15.3	31	52.5	18	30.5	1	1.7
	M (15)	1	6.7	2	13.3	10	66.7	2	13.3
	Totals (173)	21	12.1	59	34.1	62	35.8	31	17.9
Frequency Measurements	R (78)	5	6.4	18	23.1	31	39.7	24	30.8
	T (21)	9	42.9	6	28.6	4	19.0	2	9.5
	B (59)	11	18.6	33	55.9	14	23.7	1	1.7
	M (15)	1	6.7	3	20.0	9	60.0	2	13.3
	Totals (173)	26	15.0	60	34.7	58	33.5	29	16.8
Phase-Shift Measurements	R (78)	4	5.1	17	21.8	32	41.0	25	32.1
	T (21)	6	28.6	7	33.3	6	28.6	2	9.5
	B (59)	9	15.3	31	52.5	17	28.8	2	3.4
	M (15)	1	6.7	3	20.0	9	60.0	2	13.3
	Totals (173)	20	11.6	58	33.5	64	37.0	31	17.9

TABLE 11--Continued

Units		Taught in Depth No.	Taught in Depth %	Emphasized No.	Emphasized %	Discussed Briefly No.	Discussed Briefly %	Not Taught No.	Not Taught %
Measurement of Q	R (78)	3	3.8	15	19.2	34	43.6	26	33.3
	T (21)	5	23.8	7	33.3	7	33.3	2	9.5
	B (59)	7	11.9	25	42.3	25	42.3	2	3.4
	M (15)	1	6.7	3	20.0	9	60.0	2	13.3
	Totals (173)	16	9.2	50	28.9	75	43.4	32	18.5
Noise Measurements	R (78)	4	5.1	18	23.1	31	39.7	25	32.1
	T (21)	9	42.9	7	33.3	3	14.3	2	9.5
	B (59)	10	16.9	26	44.1	22	37.2	1	1.7
	M (15)	1	6.7	4	26.7	8	53.3	2	13.3
	Totals (173)	24	13.9	55	31.8	64	37.0	30	17.3
Dielectric Measurements	R (78)	3	3.8	14	17.9	35	44.9	26	33.3
	T (21)	4	19.0	9	42.9	6	28.6	2	9.5
	B (59)	7	11.9	22	37.2	27	45.8	3	5.1
	M (15)	1	6.7	3	20.0	9	60.0	2	13.3
	Totals (173)	15	8.7	48	27.7	77	44.5	33	19.1
Impedance Measurements	R (78)	4	5.1	19	24.4	31	39.7	24	30.8
	T (21)	6	28.6	8	38.1	5	23.8	2	9.5
	B (59)	12	20.3	25	42.3	20	33.9	2	3.4
	M (15)	1	6.7	5	33.3	7	46.7	2	13.3
	Totals (173)	23	13.3	57	32.9	63	36.4	30	17.3

TABLE 11--Continued

Units		Taught in Depth No.	Taught in Depth %	Emphasized No.	Emphasized %	Discussed Briefly No.	Discussed Briefly %	Not Taught No.	Not Taught %
Directional Couplers	R (78)	3	3.8	14	17.9	36	46.2	25	32.1
	T (21)	3	14.3	9	42.9	7	33.3	2	9.5
	B (59)	7	11.9	31	52.5	19	32.2	2	3.4
	M (15)	1	6.7	1	6.7	11	73.3	2	13.3
	Totals (173)	14	8.1	55	31.8	73	42.2	31	17.9
Absorption Wavemeter	R (78)	3	3.8	13	16.7	36	46.2	26	33.3
	T (21)	4	19.0	9	42.9	6	28.6	2	9.5
	B (59)	8	13.6	23	39.0	25	42.3	3	5.1
	M (15)	1	6.7	1	6.7	11	73.3	2	13.3
	Totals (173)	16	9.2	46	26.6	78	45.1	33	19.1
VSWR Measurements	R (78)	4	5.1	19	24.4	32	41.0	23	29.5
	T (21)	5	23.8	8	38.1	6	28.6	2	9.5
	B (59)	12	20.3	27	45.8	19	32.2	1	1.7
	M (15)	1	6.7	5	33.3	7	46.7	2	13.3
	Totals (173)	22	12.7	59	34.1	64	37.0	28	16.2
Coaxial-Cable Measurements	R (78)	3	3.8	17	21.8	33	42.3	25	32.1
	T (21)	6	28.6	9	42.9	4	19.0	2	9.5
	B (59)	11	18.6	22	37.2	24	40.7	2	3.4
	M (15)	1	6.7	3	20.0	9	60.0	2	13.3
	Totals (173)	21	12.1	51	29.5	70	40.5	31	17.9

TABLE 11--Continued

Units		Taught in Depth No.	Taught in Depth %	Emphasized No.	Emphasized %	Discussed Briefly No.	Discussed Briefly %	Not Taught No.	Not Taught %
Propagation Patterns	R (78)	3	3.8	15	19.2	35	44.9	25	32.1
	T (21)	4	19.0	9	42.9	6	28.6	2	9.5
	B (59)	13	22.0	21	35.6	23	39.0	2	3.4
	M (15)	1	6.7	7	46.7	5	33.3	2	13.3
	Totals (173)	21	12.1	52	30.1	69	39.9	31	17.9
Radar System Principles:									
Block Diagram Analysis	R (78)	6	7.7	19	24.4	27	34.6	26	33.3
	T (21)	4	19.0	4	19.0	9	42.9	4	19.0
	B (59)	9	15.3	27	45.8	19	32.2	4	6.8
	M (15)	1	6.7	4	26.7	7	46.7	3	20.0
	Totals (173)	20	11.6	54	31.2	62	35.8	37	21.4
CRT Types	R (78)	4	5.1	15	19.2	33	42.3	26	33.3
	T (21)	1	4.8	6	28.6	10	47.6	4	19.0
	B (59)	9	15.3	23	39.0	24	40.7	3	5.1
	M (15)	0	0.0	3	20.0	9	60.0	3	20.0
	Totals (173)	14	8.1	47	27.6	76	43.9	36	20.8
Radar Sweep Chains	R (78)	3	3.8	13	16.7	34	43.6	28	35.9
	T (21)	1	4.8	5	23.8	11	52.4	4	19.0
	B (59)	7	11.9	28	47.5	20	33.9	4	6.8
	M (15)	0	0.0	3	20.0	9	60.0	3	20.0
	Totals (173)	11	6.4	49	28.3	74	42.8	39	22.5

TABLE 11--Continued

Units		Taught in Depth No.	Taught in Depth %	Emphasized No.	Emphasized %	Discussed Briefly No.	Discussed Briefly %	Not Taught No.	Not Taught %
Range-Mark Generator Chains	R (78)	3	3.8	13	16.7	34	43.6	28	35.9
	T (21)	1	4.8	6	28.6	10	47.6	4	19.0
	B (59)	8	13.6	26	44.1	21	35.6	4	6.8
	M (15)	0	0.0	2	13.3	10	66.7	3	20.0
	Totals (173)	12	6.9	47	27.2	75	43.4	39	22.5
Delay Devices in Radar Systems	R (78)	4	5.1	13	16.7	33	42.3	28	35.9
	T (21)	2	9.5	5	23.8	10	47.6	4	19.0
	B (59)	9	15.3	22	37.2	24	40.7	4	6.8
	M (15)	0	0.0	3	20.0	9	60.0	3	20.0
	Totals (173)	15	8.7	43	24.9	76	43.9	39	22.5
Radar Modulators	R (78)	3	3.8	13	16.7	34	43.6	28	35.9
	T (21)	2	9.5	5	23.8	9	42.9	5	23.8
	B (59)	8	13.6	28	47.5	20	33.9	3	5.1
	M (15)	0	0.0	3	20.0	9	60.0	3	20.0
	Totals (173)	13	7.5	49	28.3	72	41.6	39	22.5
Magnetrons	R (78)	3	3.8	16	20.5	29	37.2	30	38.5
	T (21)	2	9.5	5	23.8	10	47.6	4	19.0
	B (59)	9	15.3	28	47.5	19	32.2	3	5.1
	M (15)	0	0.0	3	20.0	9	60.0	3	20.0
	Totals (173)	14	8.1	52	30.1	67	38.7	40	23.1

TABLE 11--Continued

Units		Taught in Depth No.	Taught in Depth %	Emphasized No.	Emphasized %	Discussed Briefly No.	Discussed Briefly %	Not Taught No.	Not Taught %
Navigational Electronics:									
Sonar	R (78)	2	2.6	12	15.4	37	47.4	27	34.6
	T (21)	2	9.5	4	19.0	9	42.9	6	28.6
	B (59)	8	13.6	22	37.2	22	37.2	7	11.9
	M (15)	1	6.7	3	20.0	9	60.0	2	13.3
	Totals (173)	13	7.5	41	23.7	77	44.5	42	24.3
Loop Antennas	R (78)	2	2.6	11	14.1	36	46.2	29	37.2
	T (21)	2	9.5	4	19.0	10	47.6	5	23.8
	B (59)	3	5.1	25	42.3	26	44.1	5	8.5
	M (15)	1	6.7	4	26.7	8	53.3	2	13.3
	Totals (173)	8	4.6	44	25.4	80	46.2	41	23.7
Radio Direction Finders	R (78)	0	0.0	11	14.1	41	52.6	26	33.3
	T (21)	2	9.5	4	19.0	10	47.6	5	23.8
	B (59)	6	10.1	22	37.2	26	44.1	5	8.5
	M (15)	1	6.7	4	26.7	7	46.7	3	20.0
	Totals (173)	9	5.2	41	23.7	84	48.6	39	22.5
Loran	R (78)	0	0.0	11	14.1	38	48.7	29	37.2
	T (21)	1	4.8	5	23.8	9	42.9	6	28.6
	B (59)	9	15.3	19	32.2	25	42.3	6	10.1
	M (15)	1	6.7	2	13.3	9	60.0	3	20.0
	Totals (173)	11	6.4	37	21.4	81	46.8	44	25.4

TABLE 11--Continued

Units		Taught in Depth No.	Taught in Depth %	Emphasized No.	Emphasized %	Discussed Briefly No.	Discussed Briefly %	Not Taught No.	Not Taught %
OTHER APPLICATIONS OF ELECTRONIC DEVICES									
Generators and Motors (Types and Theory)									
A-C and D-C Generators	R (78)	13	16.7	23	29.5	40	51.3	2	2.6
	T (21)	6	28.6	8	38.1	6	28.6	1	4.8
	B (59)	7	11.9	23	39.0	25	42.3	4	6.8
	M (15)	0	0.0	9	60.0	5	33.3	1	6.7
	Totals (173)	26	15.0	63	36.4	76	43.9	8	4.6
A-C and D-C Motors	R (78)	14	17.9	25	32.1	38	48.7	1	1.3
	T (21)	6	28.6	8	38.1	6	28.6	1	4.8
	B (59)	7	11.9	26	44.1	23	39.0	3	5.1
	M (15)	0	0.0	9	60.0	5	33.3	1	6.7
	Totals (173)	27	15.6	68	39.3	72	41.6	6	3.5
Single-Phase Principles	R (78)	16	20.5	21	26.9	37	47.4	4	5.1
	T (21)	5	23.8	8	38.1	7	33.3	1	4.8
	B (59)	8	13.6	26	44.1	22	37.2	3	5.1
	M (15)	0	0.0	8	53.3	6	40.0	1	6.7
	Totals (173)	29	16.8	63	36.4	72	41.6	9	5.2

TABLE 11--Continued

Units		Taught in Depth No.	Taught in Depth %	Emphasized No.	Emphasized %	Discussed Briefly No.	Discussed Briefly %	Not Taught No.	Not Taught %
Three-Phase Principles	R (78)	15	19.2	17	21.8	41	52.6	5	6.4
	T (21)	5	23.8	8	38.1	7	33.3	1	4.8
	B (59)	10	16.9	26	44.1	21	35.6	2	3.4
	M (15)	0	0.0	8	53.3	6	40.0	1	6.7
	Totals (173)	30	17.3	59	34.1	75	43.4	9	5.2
Converters, Inverters and Dynamotors	R (78)	7	9.0	18	23.1	45	57.7	8	10.3
	T (21)	5	23.8	8	38.1	7	33.3	1	4.8
	B (59)	8	13.6	24	40.7	24	40.7	3	5.1
	M (15)	1	6.7	4	26.7	8	53.3	2	13.3
	Totals (173)	21	12.1	54	31.2	84	48.6	14	8.1
Generator and Motor Maintenance	R (78)	13	16.7	14	17.9	38	48.7	13	16.7
	T (21)	4	19.0	8	38.1	8	38.1	1	4.8
	B (59)	8	13.6	21	35.6	25	42.3	5	8.5
	M (15)	0	0.0	6	40.0	7	46.7	2	13.3
	Totals (173)	25	14.5	49	28.3	78	45.1	21	12.1
Speed Regulators	R (78)	13	16.7	14	17.9	40	51.3	11	14.1
	T (21)	1	4.8	10	47.6	9	42.9	1	4.8
	B (59)	7	11.9	23	39.0	25	42.3	4	6.8
	M (15)	1	6.7	4	26.7	8	53.3	2	13.3
	Totals (173)	22	12.7	51	29.5	82	47.4	18	10.4

TABLE 11--Continued

Units		Taught in Depth No.	Taught in Depth %	Emphasized No.	Emphasized %	Discussed Briefly No.	Discussed Briefly %	Not Taught No.	Not Taught %
Automatic Motor Controls	R (78)	12	15.4	19	24.4	38	48.7	9	11.5
	T (21)	3	14.3	8	38.1	9	42.9	1	4.8
	B (59)	7	11.9	27	45.8	21	35.6	4	6.8
	M (15)	0	0.0	5	33.3	7	46.7	3	20.0
	Totals (173)	22	12.7	59	34.1	75	43.4	17	9.8
Synchros and Control Systems:									
Synchro Applications	R (78)	12	15.4	14	17.9	44	56.4	8	10.3
	T (21)	2	9.5	6	28.6	10	47.6	3	14.3
	B (59)	9	15.3	23	39.0	22	37.2	5	8.5
	M (15)	1	6.7	5	33.3	5	33.3	4	26.7
	Totals (173)	24	13.9	48	27.7	81	46.8	20	11.6
Synchro Principles	R (78)	14	17.9	18	23.1	38	48.7	8	10.3
	T (21)	2	9.5	5	23.8	11	52.4	3	14.3
	B (59)	9	15.3	23	39.0	22	37.2	5	8.5
	M (15)	1	6.7	4	26.7	6	40.0	4	26.7
	Totals (173)	26	15.0	50	28.9	77	44.5	20	11.6
Differential Synchro	R (78)	10	12.8	13	16.7	42	53.8	13	16.7
	T (21)	1	4.8	6	28.6	11	52.4	3	14.3
	B (59)	7	11.9	20	33.9	25	42.3	7	11.9
	M (15)	1	6.7	3	20.0	7	46.7	4	26.7
	Totals (173)	19	11.0	42	24.3	85	49.1	27	15.6

TABLE 11--Continued

Units		Taught in Depth No.	Taught in Depth %	Emphasized No.	Emphasized %	Discussed Briefly No.	Discussed Briefly %	Not Taught No.	Not Taught %
Synchro Control Transformer	R (78)	9	11.5	13	16.7	42	53.8	14	17.9
	T (21)	1	4.8	7	33.3	10	47.6	3	14.3
	B (59)	6	10.1	21	35.6	24	40.7	8	13.6
	M (15)	1	6.7	3	20.0	7	46.7	4	26.7
	Totals (173)	17	9.8	44	25.4	83	48.0	29	16.8
Geared Synchro Systems	R (78)	9	11.5	10	12.8	45	57.7	14	17.9
	T (21)	1	4.8	7	33.3	10	47.6	3	14.3
	B (59)	5	8.5	19	32.2	27	45.8	8	13.6
	M (15)	0	0.0	4	26.7	7	46.7	4	26.7
	Totals (173)	15	8.7	40	23.1	89	51.4	29	16.8
Synchro Capacitors	R (78)	9	11.5	9	11.5	45	57.7	15	19.2
	T (21)	1	4.8	7	33.3	10	47.6	3	14.3
	B (59)	5	8.5	20	33.9	26	44.1	8	13.6
	M (15)	0	0.0	3	20.0	8	53.3	4	26.7
	Totals (173)	15	8.7	39	22.5	89	51.4	30	17.3
Synchro Connections	R (78)	9	11.5	11	14.1	43	55.1	15	19.2
	T (21)	1	4.8	7	33.3	10	47.6	3	14.3
	B (59)	6	10.1	20	33.9	24	40.7	9	15.3
	M (15)	1	6.7	2	13.3	8	53.3	4	26.7
	Totals (173)	17	9.8	40	23.1	85	49.1	31	17.9

TABLE 11--Continued

Units		Taught in Depth No.	Taught in Depth %	Emphasized No.	Emphasized %	Discussed Briefly No.	Discussed Briefly %	Not Taught No.	Not Taught %
Servo Control Devices and Systems:									
Fundamental Servo Principles	R (78)	22	28.2	23	29.5	28	35.9	5	6.4
	T (21)	1	4.8	4	19.0	12	57.1	4	19.0
	B (59)	19	32.2	18	30.5	19	32.2	3	5.1
	M (15)	2	13.3	5	33.3	5	33.3	3	20.0
	Totals (173)	44	25.4	50	28.9	64	37.0	15	8.7
Common Servomechanism Systems	R (78)	17	21.8	18	23.1	38	48.7	5	6.4
	T (21)	1	4.8	5	23.8	11	52.4	4	19.0
	B (59)	11	18.6	21	35.6	24	40.7	3	5.1
	M (15)	2	13.3	4	26.7	6	40.0	3	20.0
	Totals (173)	31	17.9	48	27.7	79	45.7	15	8.7
Servomechanism Chains	R (78)	9	11.5	18	23.1	41	52.6	10	12.8
	T (21)	1	4.8	5	23.8	11	52.4	4	19.0
	B (59)	10	16.9	18	30.5	28	47.5	3	5.1
	M (15)	1	6.7	3	20.0	7	46.7	4	26.7
	Totals (173)	21	12.1	44	25.4	87	50.3	21	12.1
Frequency Response of Servo Systems	R (78)	13	16.7	22	28.2	35	44.9	8	10.3
	T (21)	1	4.8	4	19.0	12	57.1	4	19.0
	B (59)	7	11.9	21	35.6	26	44.1	5	8.5
	M (15)	2	13.3	3	20.0	6	40.0	"	26.7
	Totals (173)	23	13.3	50	28.9	79	45.7	21	12.1

TABLE 11--Continued

Units		Taught in Depth No.	Taught in Depth %	Emphasized No.	Emphasized %	Discussed Briefly No.	Discussed Briefly %	Not Taught No.	Not Taught %
Industrial Electronic Applications and Devices: Decision or Intelligence Devices	R (78)	13	16.7	24	30.8	30	38.5	11	14.1
	T (21)	3	14.3	6	28.6	8	38.1	4	19.0
	B (59)	13	22.0	18	30.5	21	35.6	7	11.9
	M (15)	1	6.7	5	33.3	5	33.3	4	26.7
	Totals (173)	30	17.3	53	30.6	64	37.0	26	15.0
Electronic Control Systems	R (78)	22	28.2	30	38.5	25	32.1	1	1.3
	T (21)	6	28.6	6	28.6	6	28.6	3	14.3
	B (59)	16	27.1	23	39.0	15	25.4	5	8.5
	M (15)	2	13.3	4	26.7	7	46.7	2	13.3
	Totals (173)	46	26.6	63	36.4	53	30.6	11	6.4
Simple Electronic Circuits	R (78)	23	29.5	24	30.8	27	34.6	4	5.1
	T (21)	3	14.3	7	33.3	8	38.1	3	14.3
	B (59)	8	13.6	25	42.3	22	37.2	4	6.8
	M (15)	1	6.7	7	46.7	5	33.3	2	13.3
	Totals (173)	35	20.3	63	36.4	62	35.8	13	7.5
Ultrasonics	R (78)	9	11.5	19	24.4	39	50.0	11	14.1
	T (21)	2	9.5	6	28.6	10	47.6	3	14.3
	B (59)	10	16.9	24	40.7	19	32.2	6	10.1
	M (15)	1	6.7	4	26.7	6	40.0	4	26.7
	Totals (173)	22	12.7	53	30.6	74	42.8	24	13.9

TABLE 11--Continued

Units		Taught in Depth No.	Taught in Depth %	Empha-sized No.	Empha-sized %	Discussed Briefly No.	Discussed Briefly %	Not Taught No.	Not Taught %
Electronic Heating and Welding	R (78)	7	9.0	15	19.2	42	53.8	14	17.9
	T (21)	1	4.8	5	23.8	10	47.6	5	23.8
	B (59)	8	13.6	20	33.9	23	39.0	8	13.6
	M (15)	1	6.7	6	40.0	6	40.0	2	13.3
	Totals (173)	17	9.8	46	26.6	81	46.8	29	16.8
Transducers	R (78)	18	23.1	24	30.8	32	41.0	4	5.1
	T (21)	0	0.0	8	38.1	9	42.9	4	19.0
	B (59)	8	13.6	23	39.0	23	39.0	5	8.5
	M (15)	0	0.0	7	46.7	6	40.0	2	13.3
	Totals (173)	26	15.0	62	35.8	70	40.5	15	8.7
Thermistors	R (78)	16	20.5	24	30.8	36	46.2	2	2.6
	T (21)	1	4.8	8	38.1	10	47.6	2	9.5
	B (59)	7	11.9	26	44.1	21	35.6	5	8.5
	M (15)	0	0.0	7	46.7	7	46.7	1	6.7
	Totals (173)	24	13.9	65	37.6	74	42.8	10	5.8
Temperature Recorders	R (78)	13	16.7	22	28.2	37	47.4	6	7.7
	T (21)	0	0.0	9	42.9	9	42.9	3	14.3
	B (59)	5	8.5	16	27.1	30	50.8	8	13.6
	M (15)	0	0.0	6	40.0	8	53.3	1	6.7
	Totals (173)	18	10.4	53	30.6	84	48.6	18	10.4

TABLE 11--Continued

Units		Taught in Depth No.	Taught in Depth %	Emphasized No.	Emphasized %	Discussed Briefly No.	Discussed Briefly %	Not Taught No.	Not Taught %
Varistors	R (78)	9	11.5	22	28.2	41	52.6	6	7.7
	T (21)	0	0.0	11	52.4	8	38.1	2	9.5
	B (59)	5	8.5	29	49.2	20	33.9	5	8.5
	M (15)	0	0.0	6	40.0	8	53.3	1	6.7
	Totals (173)	14	8.1	68	39.3	77	44.5	14	8.1
Time-Delay Relays	R (78)	12	15.4	19	24.4	40	51.3	7	9.0
	T (21)	0	0.0	14	66.7	5	23.8	2	9.5
	B (59)	5	8.5	24	40.7	26	44.1	4	6.8
	M (15)	0	0.0	5	33.3	7	46.7	3	20.0
	Totals (173)	17	9.8	62	35.8	78	45.1	16	9.2
Large-Current Poly-phase Rectifiers	R (78)	7	9.0	17	21.8	36	46.2	18	23.1
	T (21)	1	4.8	8	38.1	9	42.9	3	14.3
	B (59)	8	13.6	18	30.5	25	42.3	8	13.6
	M (15)	1	6.7	4	26.7	5	33.3	5	33.3
	Totals (173)	17	9.8	47	27.2	75	43.4	34	19.7
High Frequency Wave-lengths	R (78)	4	5.1	15	19.2	42	53.8	17	21.8
	T (21)	2	9.5	7	33.3	9	42.9	3	14.3
	B (59)	9	15.3	23	39.0	24	40.7	3	5.1
	M (15)	0	0.0	6	40.0	4	26.7	5	33.3
	Totals (173)	15	8.7	51	29.5	79	45.7	28	16.2

TABLE 11--Continued

Units		Taught in Depth		Empha-sized		Discussed Briefly		Not Taught	
		No.	%	No.	%	No.	%	No.	%
High-Speed Light and Register Controls	R (78)	3	3.8	15	19.2	43	55.1	17	21.8
	T (21)	2	9.5	5	23.8	11	52.4	3	14.3
	B (59)	7	11.9	23	39.0	21	35.6	8	13.6
	M (15)	1	6.7	4	26.7	6	40.0	4	26.7
	Totals (173)	13	7.5	47	27.2	81	46.8	32	18.5
Thyratron Controls	R (78)	6	7.7	11	14.1	47	60.3	14	17.9
	T (21)	1	4.8	5	23.8	12	57.1	3	14.3
	B (59)	6	10.1	17	28.8	27	45.8	9	15.3
	M (15)	0	0.0	3	20.0	6	40.0	6	40.0
	Totals (173)	13	7.5	36	20.8	92	53.2	32	18.5
Electronic Timer Circuits	R (78)	14	17.9	26	33.3	34	43.6	4	5.1
	T (21)	1	4.8	8	38.1	8	38.1	4	19.0
	B (59)	7	11.9	22	37.2	25	42.3	5	8.5
	M (15)	1	6.7	7	46.7	6	40.0	1	6.7
	Totals (173)	23	13.3	63	36.4	73	42.2	14	8.1
Radiation Inspection and Detection	R (78)	9	11.5	19	24.4	36	46.2	14	17.9
	T (21)	1	4.8	5	23.8	11	52.4	4	19.0
	B (59)	9	15.3	21	35.6	22	37.2	7	11.9
	M (15)	2	13.3	3	20.0	6	40.0	4	26.7
	Totals (173)	21	12.1	48	27.7	75	43.4	29	16.8

TABLE 11--Continued

Units		Taught in Depth		Empha-sized		Discussed Briefly		Not Taught	
		No.	%	No.	%	No.	%	No.	%
Photoelectric Devices	R (78)	10	12.8	27	34.6	37	47.4	4	5.1
	T (21)	1	4.8	4	19.0	13	61.9	3	14.3
	B (59)	5	8.5	29	49.2	20	33.9	5	8.5
	M (15)	1	6.7	7	46.7	7	46.7	0	0.0
	Totals (173)	17	9.8	67	38.7	77	44.5	12	6.9

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